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WOODHOUSE AND RAWSON LAMPS IN THE PHILADELPHIA TESTS.

A MONTH or so ago we published a letter from Messrs. Woodhouse and Rawson relative to the tests of incandescent lamps of their manufacture by a Committee of the Franklin Institute, Philadelphia. We then gave it as our opinion that they were ill-advised in taking the action they did, as, had they attentively perused our columns they would not have remained in ignorance of the proceedings in Philadelphia, as they claim to have done, and would have seen that the circumstances under which their lamps were included in the tests were fully explained in the committee's report. The attention of the President of the Franklin Institute, Mr. W. P. Tatham, has been attracted to Messrs. Woodhouse and Rawson's letter, which was communicated to other journals besides our own, and he has written at some length in a contemporary in refutation of their assertions. Mr. Tatham's letter, we may remark, fully corroborates every statement we made at the time, and clearly shows that no cause for the complaint existed, so far as the Franklin Institute was concerned.

Messrs. Woodhouse and Rawson complained, first, that their lamps were tested without their knowledge or consent, and, second, that their lamps were run at five volts above what they were labelled. Mr. Tatham gives the following account of the manner of receiving the lamps, and the treatment which they received:—

"Two lots of their lamps were tested. The first lot, selected at random from a barrel of lamps belonging to the Van Depoele Company, were labelled 20 candles, 55 volts. They were tested and run at 55 volts. No. 9, with resistance cold of 106 ohms, lived longest, 715½ hours. No. 2, resistance cold 102 ohms, exhibited phenomenal brilliancy. The complaint that this lot of lamps was entered without their knowledge or consent may be well founded. The second lot of lamps was received through the Edison Company. I now learn that the origin of this transaction was as follows:—At a meeting of the London Society of Arts, held December 3rd, 1884, Mr. Wm. H. Preece, F.R.S., read a paper upon 'Electric Illumination,' in which appeared the following language (see *Journal* of the Society of Arts, December 5th, 1884, page 73):—'The efficiency of the glow lamps has also been very considerably affected by the improvement made, for instance, by Messrs. Woodhouse and Rawson and by Mr. Bernstein. The efficiency of the Edison lamps means the consumption of energy at the rate of five watts per candle, but lamps are now being made which give an efficiency of two and a-half watts per candle with an equal life, which is equivalent to an immediate reduction of 50 per cent. in the amount of energy required to maintain the system alight, and therefore in the cost of production. Whereupon the Edison Company challenged Mr. Preece to produce such lamps and have them tested by the Franklin Institute, whose committee was preparing for the tests which afterwards were made. Mr. Preece procured the lamps and forwarded them to the Edison Company, whose letter dated April 13th, 1885, to Prof. Marks (who acted as an executive committee), says:—'Mr. Preece, the electrician of the English Post Office, has sent to Mr. Edison a number of Woodhouse and Rawson lamps. They are now in the New York Custom House. We have given directions to have them forwarded to you at the Electrical Exhibition in the original packing as soon as they are appraised.' At that time our test boxes were all occupied and our current employed. Inside of the box, when received, was found a large label addressed 'for Mr. Wm. H. Preece, 20 candles, 50 volts.' The usual label of Woodhouse and Rawson was on every lamp, altered, however, so as to read as above, the figure 0 in the number 50 being written over an erasure. The resistances cold of all the lamps tested were nearly uniform, five at 100 ohms; two, each 99 and 101 ohms, and one 102 ohms. [See Report, Table VI., page 38.] These circumstances persuaded us that the lamps were not selected by chance."

With regard to the second point of Messrs. Woodhouse and Rawson's complaint, Mr. Tatham says that upon discussing the preliminary results the judges found it impossible to follow the label. Twenty candles illumination could not be had with 50 volts; and they decided to raise the electromotive force. The preliminary tests showed the lamps to be both dim and dear when tested with 50 volts, and as to their duration, the remaining time of the tests, about 300 hours, would furnish no proof. Thus, it will be seen, it was out of consideration for the makers of the lamps that the judges raised the electromotive force and refrained from publishing a full statement of the preliminary test with the 50 volts.

ALTERNATING CURRENTS AND THEIR PART IN ELECTROTECHNICS.*

By MAX DERI.

INDUCTION is one of the most important physical phenomena of which we avail ourselves in electrotechnics. With induction is most closely connected the so-called intermittent current, and, as the result of continued action, also alternating currents.

From this fact I draw the conclusion, for which I will offer reasons in the course of this paper, that alternating currents are not only destined to play a most important part in electrotechnics, but that they already fulfil requirements far more important than many people imagine.

I know that in this country there exists, even amongst some of our professional colleagues, a kind of antipathy to, or rather a vague shyness of, alternating currents. I have often heard myself the hesitating objection, "Yes, but alternating currents. . . . ." When I made enquiry into the nature of the objection, I received either a very unsatisfactory answer or no answer at all.

I repeat that this shyness exists in this country only; in other countries, where electrotechnics progress as rapidly as with us, it is scarcely known. In order to substantiate this, I mention, as an instance, that our fellow member, Mr. Zipernowski, made this year (1885) a tour through Western Europe with the view of interesting professional circles in an invention exclusively based on the application of the alternate

* A paper read before the Elektrotechnische Verein, in Vienna, on the 18th of December, 1885.

currents. He did, no doubt, meet with many objections and adverse criticisms, but on no occasion was the invention objected to on account of its using alternating currents. No one evinced the least dread of that. Such electricians as have gained with us a considerable reputation in their application of the continuous currents took a keen interest in the invention, and strove zealously to promote its exploitation.

What, then, is there to be dreaded? What is the cause of that prejudice against alternating currents which obtains in our country?

It is asserted by many that alternating currents are dangerous and not economical; that is, that they have little useful effect, both in the way they are generated and applied.

What the origin of those accusations is will be made evident by a rapid retrospect of the history of the development of the electric currents. You will see how easily mere appearances may lead us into error.

At first battery currents—that is continuous currents—only were known. Those currents could be handled without danger, as their tension was comparatively low. How, indeed, would it have been possible to set up by means of elements electromotive forces of several hundreds or thousands of volts, when it was quite a difficult problem to produce the 50—60 volts required for an arc light. For an arc light quite a respectable army of elements, a battery which filled up a whole room, was requisite.

Later on, after the discovery of induction, when the physiological actions of the current became known, that very same induction was used for the generation of higher electromotive forces. The battery currents, whose tension was so low that they had no effect at all on the nerves, were transformed into currents of higher tension which were able to shock the nervous system. Those currents were either the so-called extra currents, or the secondary currents produced by Ruhmkorff's coil. The currents of higher tension were then always induction currents; and induction generates nothing but *alternating currents*.

Currents of higher tension were then generated for the purpose of acting on the human organism; and because those currents invariably happened to be—in virtue of the manner in which they were generated—alternating currents, what was more natural than that with the notion of alternating currents that of danger was associated. The delusion was so easy. It was known that a current from 10 elements did not irritate the body at all, but that current being connected to an induction apparatus, each interruption of the current caused pain. The conclusion was, therefore, a continuous current is harmless, each interruption current hurts, therefore alternate currents are dangerous.

You are all aware that this is a great delusion. Let us make the following experiment:—If we close a battery of a few elements in such a manner that no self-induction can occur, for instance, by a wire or by incandescence lamps, &c., we can interrupt such a circuit a hundred times slowly or rapidly, and no action will be observed; but if we close the same battery by a conductor of considerable self-induction, for instance by a bobbin with many windings containing an iron core, each interruption will be made painfully manifest. Now, we have seen that the interruption of one and the same current was in the first case without effect, but that it exhibited in the second case a very powerful action. Why is this so? Because the interruption itself has no effect, but it is the current that is set up by the induction at the moment of the interruption which has the power to irritate the nerves if it only possesses the requisite tension. But such an induction current was not present in the first case, whereas in the second case a current was produced, which was so violent in its action, because its electromotive force was much higher than that of the original battery current itself.

I will illustrate this with an example, perhaps more familiar to you. Let us take a dynamo machine with powerful magnetic fields, an Edison machine, for instance. The field magnet cores are wound with copper wires of extraordinary length, and those coils are, as you know, joined to the pole terminals of the machine so that they may form a branch circuit. The difference of potential at the terminals is about 100 volts, the field magnet coils consequently receive only 100 volts. No one needs to be afraid to touch the ends of those coils with naked hands, for it is well known that a difference of potential of 100 volts is harmless. But let, on the contrary, everybody beware of touching those ends at the moment that the circuit formed by the coils is suddenly interrupted. In consequence of the sudden demagnetisation of the iron a momentary current is set up in the coils, whose tension may amount to several hundred volts. But if we interrupt the external circuit, which is formed by incandescence lamps, we shall scarcely feel that interruption, although a current of 100 volts is interrupted there also.

A trial of only a second's duration is sufficient in the first case to cause the imprudent experimenter to stagger; whilst, in the second case, the interruptions may be continued for hours as rapidly as possible without the least danger of shaking the nerves.

Thus you see that it is not the change of direction of the current, nor its duration, but solely its tension which causes the danger.

But there were other accidental circumstances which tended still more to confirm that erroneous idea. You will recollect the invention (about eight years ago) of the so-called "subdivision of the electric light," that is, the possibility of feeding several arc lights in one series by one dynamo machine. First of all we had the Jablochkoff candles for which Lontin and Gramme designed their alternate current machines, and, afterwards, Siemens lamps, which were fed by his alternate current machines. No other machines were at that time better suited to that purpose. Thus were, for the first time, currents of higher tension introduced into electric lighting: then was heard, for the first time, the caution: Take care! it is dangerous to touch the conductors, &c.; and as those high tension currents chanced to be alternate currents, it was again believed that those currents only were dangerous. No attention was paid to the fact that the continuous current machines of Brush with their 1,000—2,000 volts, which were introduced soon after, were far more dangerous than the alternate currents.

It was likewise an error to consider the physiological action of a current proportional to its quantity. If we touch one or two points of a conductor, the quantity of current circulating in that conductor is immaterial; that current only which passes through the body is effective. If we touch two points whose difference of potential is 100 volts, the action on our organism is the same whether 1 ampère or 1,000 ampères circulate. Our body offers a certain resistance between the two points touched, therefore the current passing through it is equal to the quotient of the difference of potential, 100, divided by the resistance of the body. This value, which represents the physiological action of the current only, is, therefore, totally independent of the quantity of current flowing through the circuit.

If we wish to judge of the danger of a circuit, we must determine the maximum difference of potential which can ever occur, or may possibly occur, between any two accessible points of the conductor. Suppose, for instance, we join up many lamps in series, as in the case of arc lamps, or of the groups of incandescence lamps in Temesvar, each lamp, or group of lamps, will perhaps require 50 volts; between the terminals of that lamp or group of lamps there will therefore be a difference of potential of 50 volts. But if that circuit is interrupted at any point by a lamp, there will be a far higher tension at that point, namely of as many volts as the dynamo machine is capable of yielding for the whole series of lamps.

To resume: *it is the difference of potential between the points of the conductor touched by the body and not the duration or the direction of the currents in which the danger lies.*

Consequently, a current, whether continuous or intermittent, or alternating, can only be dangerous when it

has a high tension, and each current is harmless when it has a low tension, say of 100 volts or less.

I hear some one make the remark that a difference between current and current—between continuous currents and alternating currents—must exist in any case. That is correct; a difference does exist. It is as follows:—

The tension of a continuous current is a value which remains unchanged during a finite period, but the tension of an alternate current is only a mean value, as is shown by the instrument, which is unable to follow the extraordinarily rapid reversals of the current.

But if we consider the differences of potential in infinitely short spaces of time, we find, of course, that they are values which are greater, and, again, values which are less than the measurable value of the tension which qualifies the current.

The maxima are greater than the mean value, and, although for all the other actions of the alternating currents the latter value is effectual, in the case of the physiological action the maximum value prevails, as I pointed out before.

What proportion is there between maximum and mean value? It has been several times attempted to determine that proportion. Herr Uppenborn two years ago estimated the ratio at about 0·56 (I do not recollect the exact figures), that is, the maximum value is to the mean value as 100 : 56.

But I believe that there cannot be a fixed ratio, for it must depend on the form of the diagram, and I believe each dynamo machine has its own diagram. It is certain that the more perfect the induction the flatter will be the top of the diagram, and the nearer will be the mean value to the maximum.

It is further certain that the figures 0·56 can easily be exceeded, and that it would not be impossible for the proportion to come very near to 1 : 1.

So, then, my assertion that an alternating current of a low electromotive force, of 100 volts or less, is not dangerous is proved; but I must admit that, under conditions otherwise equal, the safety limit of the electromotive force of the alternating current must be held to be 20, 30, or 40 per cent. lower than in the case of a continuous current.

After what has been said, you will certainly agree with me that the sweeping assertion that all alternating currents are dangerous is a great injustice.

It is admitted that a current whose electromotive force never exceeds 200 volts harbours no danger. The English Parliament, no doubt advised by the most eminent experts, have recognised that fact. Therefore no one should feel any doubt that an alternate current of an electromotive force of, for instance, 100 volts is absolutely without danger.

In order to ensure safety it is essential that, in house conductors for electric current of any description, and in lamps which are attended to by unskilled persons, none but currents of low tension should circulate; and that such conductors as must necessarily convey currents of high tension should be inaccessible to the uninitiated. To experts there is, of course, little danger. We heard recently in this place a lecturer cite the following saying of Sir William Thomson: "A current of an electromotive force of several thousand volts in the workshop is less dangerous than a circular saw."

Many persons are of opinion that alternating currents cannot be generated by dynamo machines with the same useful effect as continuous currents. This opinion, in so far as it is intended to be general in its scope, is likewise founded on error, as I will now proceed to show. In order to enable me to do so, allow me to explain, from a practical point of view, the action of induction, which is the real cause of the alternating currents.

If a conductor, of which we consider a certain length only, is in that physical condition which we indicate figuratively by saying that when an electric current is flowing through it certain curves are formed in it, or magnetic lines of force circulate in the atmosphere immediately surrounding that conductor. If the conductor is surrounded by air only, that magnetic atmosphere is of but little extent, and the circulation of lines of force weak. The same is the case when most of the other substances known to us surround the conductor; but if that substance should be iron it is different. Iron offers much less resistance to the lines of force. It is a fact that the circulation is incomparably stronger in a piece of iron when brought near to the electric conductor than in other substances. The iron is then in that condition which we call magnetic, and magnetic poles are formed at those points where the lines of force enter the atmosphere, forming magnetic fields.

Is it necessary to do work, that is, to consume energy, in order to maintain the iron in its magnetic condition? Strictly speaking, No. By magnetising a mass of iron we produce no energy, we must therefore consume no energy for that purpose. On what does the intensity of the magnetic fields really depend? The magnetic condition is the more intense as the electric current in the conductor is the stronger, and the iron is the nearer to that current. But if we wish to consider not only the intensity but also the power of the magnetic fields, the length of the active conductor is a factor which must be taken into the account. We say, practically, the magnetism of a mass of iron is proportional to the product of the ampère turns, because, in practice, we actually wind the conductor closely around the iron.

The wire which forms the coil of the magnet core has, it is true, a certain resistance, and current energy is always converted into heat, in accordance with Joule's law $J^2 r$, but this is really nothing but a *practical necessity*.

But the case is different if we need not spare the material. We have produced with $J^2 r$ a certain magnetic intensity in a certain mass of iron, by causing the J-ampères to circulate in a spiral around the iron. If we increase both the length and the section of the wire of the coil tenfold, its resistance will remain unaltered. The same electromotive force will produce the same number of ampères, and the consumption of current energy, $J^2 r$, will remain the same. But, on the other hand, we have now ten times the number of ampère turns, and consequently produce in our mass of iron a magnetic-field ten times as powerful.

Thus we can with the same electrical energy produce a hundred, or a thousandfold the magnetism, and we may say that with an infinitely small electrical energy, infinitely powerful magnets can be made.

In practice, however, infinity does not exist; but for the terms infinitely small and infinitely great we may substitute extraordinarily small and extraordinarily great. Prof. von Waltenhofen has proved that for the magnetisation of a ton of iron to saturation, not more than 15 kilogrammemetres of effect are required.

In other words, magnetism is a force, but in itself not an energy-producer. In order to do work by means of continuous currents induced by magnetism, we must have the assistance of another factor, namely, motion. By means of motion we can multiply the small electrical energy which produced the magnetism; that is, we can by setting the magnetism in motion generate electric currents far more powerful than the exciting current. That is the fundamental principle of dynamo-electricity.

If we impart motion to a second conductor more or less parallel to the first conductor, so that it cuts the lines of force, an electric current will be produced in it. If we now close that conductor we can easily convince ourselves of the existence of the current, but that current only exists whilst the motion of the conductor across the lines of force continues.

And that is the dynamo-electric machine in its simplest form. It is immaterial whether the magnetic-field of the iron is permanent or produced by some source of electricity, or whether it is strengthened and maintained by the electric energy produced in the mass of iron itself.

Let us take a single turn of wire and move it within a magnetic-field. It will cut the lines of force. As long as the density of the lines of force within the

turn remains unaltered, no resistance is offered to the motion of that turn and no current flows through it. But as soon as the magnetic intensity within the turns of wire increases or decreases, the motion is impeded and an electric current in one or the other direction is generated; if the turn is moved from a less intense to a more intense magnetic-field an electric current will flow in a certain direction, but if the turn passes from an intense to a less intense magnetic-field a current will flow in the opposite direction.

(*To be continued.*)

ON THE RUNNING DOWN OF BATTERIES AS INFLUENCED BY THEIR PERFORMANCE OF MECHANICAL WORK.

By Dr. OLIVER LODGE, in the *Engineer*.

ALTHOUGH there is nothing but what is perfectly well known in the relation between the running down of a battery and the amount of external work it is doing, yet, inasmuch as batteries are not unlikely to be more and more generally used as sources of mechanical power, it may be worth while to answer the question of the Cromer "Student" in your issue of 22nd January somewhat fully.

The correspondent describes an interesting model of an electric hammer driven by a battery, which does about 150 foot-pounds of work per minute, or has about the two-hundredth of a horse-power; and he then proceeds to say that whereas the books tell him that his battery should run down faster when the hammer is stationary than when it is at work, he finds no such result; and he implies, or at least it is not unnatural for him to think, that he would have expected the battery to run down faster while doing mechanical work than while not.

Now the first thing to thoroughly grasp is that the consumption of material in a battery is simply proportional to the strength of current flowing through it; provided, of course, all local action is avoided; it depends on the quantity of electricity transmitted, and on nothing else. The amount of zinc dissolved in every cell of a series battery per ampère hour is accurately known, and is 1·21 grammes.

Hence any cause which increases the strength of current hastens the running down of the battery; and any cause which opposes the current retards the consumption of material. Now the performance of mechanical work of whatever sort, by a current, necessarily sets up an opposition E.M.F. and weakens the current, as may be proved, and was proved by Helmholtz in 1847, as follows:—

Let E be the electromotive force of a battery, supposed constant; and let C be the current flowing round a circuit of total resistance, R, resistance also being supposed constant. Then, by definition of E.M.F., the "horse-power," or work done per minute by the current, is E C.

As the current flows round the circuit heat is generated, and this heat was found by Joule experimentally to equal $R C^2$ per unit of time.

Now if we first suppose that there is no working machine in the circuit—*i.e.*, no machine actually at work—stationary machines there may be as much as one pleases, and they may be holding up weights; but they must not be moving either in the way of raising or lowering them, neither must there be any chemical decomposition going on, or any form of activity other than that already considered in the battery; I say, given all these conditions, it follows, by the conservation of energy or the first law of thermo-dynamics, that

$$E C = R C^2 \qquad (1)$$

an equation which asserts, when we compare it with the Ohm's law definition of R $\left(R = \frac{\text{E.M.F.}}{\text{current}}\right)$, that throughout the circuit, under the supposed circumstances, there is no E.M.F., but E.

But now make another supposition: Suppose a working machine, or a decomposition cell, or some other form of activity, introduced into the circuit, whereby the current shall be made to do work—raising weights, for instance, or turning machinery—and let the horse-power of this machine be called P. Then no longer can we equate the power of the battery with the heat produced; we are compelled to take into account every form of energy which is being developed, mechanical or chemical as well as thermal, and so our equation becomes—

$$E C = R C^2 + P \qquad (2)$$

And if again we compare *this* with the Ohm's law definition of R $\left(R = \frac{\text{E.M.F.}}{C}\right)$ we find that E is no longer the sole or effective E.M.F. in the circuit, but that the total E.M.F. is $E - \frac{P}{C}$; that is, there is an opposition E.M.F., of strength $\frac{C}{P}$, and it is natural to consider this opposition E.M.F. as set up in and by the moving machine; or in and by the decomposition cell, if such it be that has been included in the circuit, in which latter case the opposition E.M.F. is known as polarisation. And be it noted that it matters not whether decomposition goes on in a special cell or in one of the battery cells—*wherever* it goes on it subtracts its full quota of E.M.F. from the current, and is equally well called polarisation.

It is plain then that, since by an active machine the total E.M.F. of the circuit is diminished while its resistance remains unaltered, it follows that the current must be weakened. And inasmuch as the wear of the battery depends simply on the current, the wear of the battery is likewise reduced by the activity of the machine.

It is easy enough to write down an expression for the strength of the current in terms of the power which the machine is exerting, *i.e.*, the work it is doing per second, by simply solving equation (2); and it is

$$C = \frac{E}{2R}\left\{1 + \sqrt{\left(1 - \frac{4RP}{E^2}\right)}\right\}$$

which shows that the greatest possible mechanical power obtainable by perfect appliances from the given circuit is $\frac{E^2}{4R}$; and that when this is obtained an equal amount is expended in generating waste heat. Moreover it shows that the consumption of material in the battery under these circumstances is exactly half what it is when the machine is held stationary and not allowed to work, and that no slower battery-wear than this half-rate is possible, so long as the machine is really worked by the battery and is not driven by some outside power; but that any faster wear is easy, up to the maximum, when the machine is stationary, of $\frac{E}{R}$.

The maximum rate of wear is $\frac{E}{R}$, corresponding to external power, 0, and internal or waste power $\frac{E^2}{R}$;

The minimum rate of wear is $\frac{E}{2R}$, corresponding to external power $\frac{E^2}{4R}$ and internal or waste power $\frac{E^2}{4R}$.

But if the mechanical power obtained be small and insignificant compared with that put forth by the battery, as is always the case with small size models which can never be efficient and economical motors,

then the rate of wear is so nearly equal to its maximum value $\frac{E}{R}$ as to be indistinguishable from it except by careful measurements.

Just one point before closing. No more work is called for from the battery whether a solenoid be sustaining a weight or keeping a piece of iron magnetised, or whether it is doing no such thing. Under all stationary circumstances the whole of the energy is frittered away as heat in the coil: the mere holding up of the weight or keeping a magnet excited involves no direct expenditure of energy. For a weight may be supported by a pillar, or a magnet may be struck into permanence by hardening it and fixing its molecules.

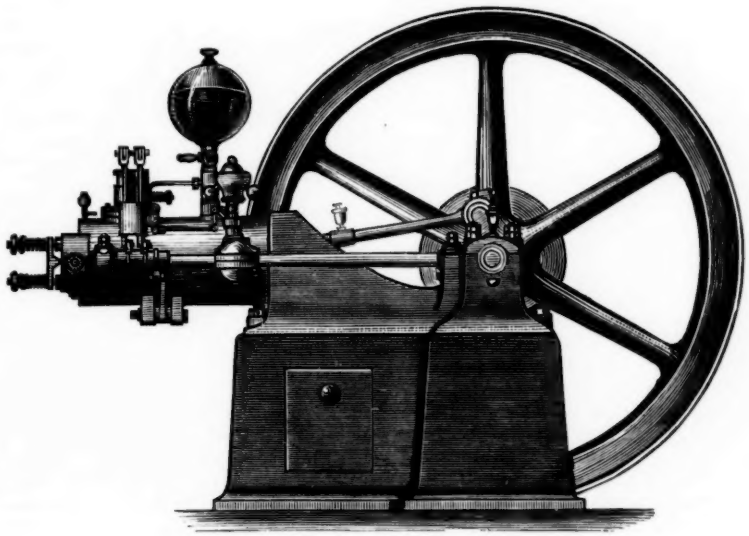
But a weight may also be supported by a man, or by a jet of water, and a magnet may be maintained by a constant current flowing round it: is there no expenditure of energy here? Do not the things get tired?

Yes, in truth they do, and there is expenditure of energy, *but not in holding the weight or maintaining the magnet*; it is all expended in bye-issues, it all reappears as heat. If we knew no simpler plan of keeping a weight supported than by keeping a man to hold it up, like Atlas, we should have to pay him his day's wage and keep him working, wastefully generating heat: but we do know a simpler plan—we use a prop. Similarly, as we know no simpler means of maintaining a powerful magnet than by keeping a current constantly flowing round it we have to keep such a current flowing, although we feel that it is really all running to waste, and that a simple prop would be a far better plan. This, however, is the present state of our ignorance; we know no prop for magnetism of any real strength. Here is a field for discovery; the field magnets of twentieth-century dynamos will probably be permanent ones, with the initial magnetic susceptibility of the softest iron, struck into the magnetic rigidity of the hardest steel.

SPIEL'S PETROLEUM ENGINE.

A VERY neat and successful form of petroleum engine, invented by Mr. Johannes Spiel, of Berlin, has lately been introduced into this country, and it is described in the current issue of *Engineering*. In its general appearance the engine, which we illustrate this week, very much resembles the well-known Otto motor, the points of difference relating mainly to the devices by which the motive fluid is measured and delivered to the cylinder, in admixture with the proper proportion of air. The cycle of operations is that with which the reports of the gas engine law cases have familiarised all the world; the piston on its outstroke draws in a charge of air and petroleum; it then returns compressing this mixture, which is exploded as the crank passes the back centre. The next stroke sees the combustion and expansion of the charge, while the fourth and last stroke of the cycle drives out the products of combustion. There is thus one acting stroke in every four, the motion being continued through the other three by the energy stored in the flywheel.

The source of power is petroleum spirit, otherwise known as benzoline, and also as naptha. This has a specific gravity of ·7 or ·71, and a very low flashing point, so that it will not pass the Abel test; consequently it cannot be stored and used without special precautions. If the proper conditions are observed the use of this spirit does not involve any extraordinary risk, for it is employed in large quantities in the dry cleaning process, and also in the manufacture of India-rubber. When used with this engine it is stored in a closed receptacle connected by a pipe and hand pump to the reservoir. From this reservoir there runs a pipe to a pump, by which measured quantities are injected into the cylinder.



The firing light is the flame of a lamp which is kept constantly burning. At a suitable moment it ignites the burner in the valve, and by the quick return movement a flash is transported to the firing apparatus in the cylinder. The combustible mixture finds its way into the burner during the compression stroke. In front, and surrounding the burner, is a chamber which serves to convey a flame from the outer jet to the charge in the cylinder. The chamber forms an annular space round the burner, and a passage opens into this space, and maintains a communication for the supply of the combustible gas or vapour during the times when the main passage is closed. The gas passing through flows round the burner, and thus becomes heated and ignites more readily. When the chamber is filled with gas it is ignited by the outer flame, and continues to burn during the return stroke of the firing valve until the chamber comes opposite the main passage, when the charge in the combustion chamber of the cylinder is ignited. The maintenance of the firing flame is effected by the flow of gas through the passage.

The engine at present in this country will work up to 3½ brake horse-power, with a consumption of about

one quart of benzoline per horse-power per hour; the same rate of consumption is also obtained if the power be reduced to 2 horse-power. At the rate of 8d. per gallon, this represents an expenditure of 2d. per brake horse-power per hour. The motor works very satisfactorily, does not clog in the valves or cylinders, and bids fair to find a good field where gas is unattainable and the local rules concerning the storage and transport for petroleum spirit are not too stringent.

The engine is being introduced in this country by Messrs. Crozier & Co.

AN INTERESTING ELECTRIC LIGHT INSTALLATION.

THE installation of the electric light at the hunting seat of H.M. the Emperor of Austria in the Zoological Gardens at Lainz was entrusted to the firm of B. Egger and Co., of Vienna, that firm also manufacturing and supplying the electric machinery. The installation comprises about 250 incandescence lamps of 16 candles each for the illumination of the castle, kitchens, stables, and courtyard; and 120 lamps of 25 candles each for the lighting of the road.

The house which contains the machinery—the boiler being located in a separate room—has been erected near the main buildings in such a manner as to be concealed, and not to constitute an eye-sore. Two rooms for the attendants have also been provided.

With regard to the plant the greatest economy, compatible with the provision of a certain amount of reserve power, mechanical and electrical, was to be strictly observed. The following particulars of the installation will show that this was successfully accomplished.

The steam engine, as well as the boiler, was supplied to the contractors by the Simmering Engine and Waggon Construction Company (late H. D. Schmidt).

The boiler is cylindrical, with two internal flues; it will sustain a pressure of 6½ atmospheres. The heating surface is 63 square metres, and the grate surface is 2 square metres. The furnace doors are connected with the damper in such a manner that their partial opening causes a corresponding closing of the damper. The boiler is set in brickwork, and its exposed parts are carefully covered over with cork, so as to prevent the dispersion of heat.

In this manner 19 kilogrammes of the evaporated water per square metre are rendered available with a minimum consumption of fuel, so that the boiler is capable of supplying steam equal to 80 indicated H.P. per hourly evaporation of 1,200 litres of water (assuming that non-condensing engines consume 15 kilogrammes of steam per indicated H.P.).

The engine is required to work normally up to 35 H.P. It is a twin engine with cylinders coupled under 90°. Diameter of cylinders 325 millimetres, stroke 650 millimetres, number of revolutions 65 per minute.

If one of the cylinders should be damaged, the other cylinder will be able to supply the required 35 H.P.

The admission of the steam, which is effected by a Waniek precision slide valve, is regulated by a Porter governor. The main steam pipe is 120 millimetres in diameter, the cylinder steam pipes 80 millimetres each, the main exhaust 150 millimetres, and the cylinders exhaust 110 millimetres each.

The cylinders are surrounded with cork and wood. A super-heater of about 16 square metres heating surface is provided.

An eccentric on the crank axle works a plunger feed pump, sunk in the floor, of 100 millimetres diameter and 120 millimetres stroke. All the pipes leading to and from the engine are placed beneath the floor.

The driving pulley of the engine rotates by rope gearing of the best hemp a driving shaft by which four dynamo machines are set in motion by means of belt gearing.

Two of the four dynamos light the buildings, and the other two light the road. The machines which illuminate the castle feed about 250 lamps of 16 candles each. Each machine is, however, constructed to run a maximum of 170 lamps. They are continuous current shunt-wound machines of 110 volts between the terminals, and are coupled together. The internal resistance of each machine is 0·1 ohm. The current is regulated by means of resistances switched into the the shunt. The machines are driven at 750 revolutions per minute, feeding 9·6 lamps per H.P.

The incandescent lamps in the castle buildings are joined parallel. The wires are well protected and placed underground; they are made up into lead cables enclosed in tubes of prepared wood, or into cables embedded in the best asphalte and contained in solid wooden boxes. Specially insulated wires are used for the connections of the lustres.

The road which is lighted by electricity leads from the engine house to a place called Speising, whilst a branch connects it with the hunting seat. It is about 3,600 metres long.

The lamps are joined in series; they are provided with automatic shunts in order to provide against an interruption of the circuit by the casual breaking of a lamp. The lamps used are the Bernstein (Boston) incandescence lamps of about 6 ohms resistance each, giving a light of 25 candles when fed by a current of 3·5 ampères, with an E.M.F. between the terminals of 18 volts. The lamps are enclosed in globes of frosted glass, they are fixed on posts on both sides of the road at a distance from one another of 30 metres.

The lamps on each side of the road form separate circuits which are each fed by a dynamo, so that, if one of the dynamos should be thrown out of use by some accident, the other side of the road would still be sufficiently lighted. The line along the road consists of uncovered copper wire, 3 millimetres thick, fastened to insulators of porcelain fixed on the lamp posts. The leads are of the best insulated material and pass through porcelain tubes into the hollow post and thence to the lamp. The whole resistance of each circuit, inclusive of the automatic contacts, is 20 ohms. It may be mentioned here that a telephone line from Schönbrunn to the hunting seat is carried along the lamp posts, and that the correspondence does not suffer the least interruption from the lighting current.

The two dynamo machines which light the road have an internal resistance of about 60 ohms; their speed is 750 revolutions per minute. The measuring instruments used are the voltmeter and the ampèremeter, &c. (Drexler's system); for the buildings' circuit 1 voltmeter is used, and for the road circuits 1 ampèremeter for each circuit. Those apparatus are provided with controlling bells and automatic contacts, so that the attendant is informed of the admissible minimum or maximum current strength. The cost of the entire installation amounted to 48,000 Austrian florins (£4,800).

As the firm of B. Egger & Co. manufacture the Boston incandescence lamps at their works, we may say that the whole electrical plant, inclusive of the measuring instruments, &c., was constructed by them. —*Zeitschrift für Elektrotechnik.*

ELECTRIC LOCOMOTION.

By A. RECKENZAUN.

VIII.

LET us now consider the case of a tramway which is to be worked electrically; the energy we assume is to be transmitted through a conductor; it may be an overhead conductor on the Siemens plan, or underground as used by Mr. Holroyd Smith, or a side conductor as adopted by Mr. Trail in Ireland. We take for an example a line, A, B (fig. 8), with a double track; the distance from the starting point, A, to the terminus, B,

is 3 miles; each car has thus to travel 6 miles to perform a double journey. There are no sharp curves, but the road is not level by any means. Starting from A we have a downward slope of 1 in 75 for a distance of ·3 of a mile, then a level piece of ·2 of a mile in length, then follows an up gradient of 1 in 30 for the short bit of ·14 of a mile; next comes a level road of 1 mile in length, then a down gradient of 1 in 50 for ·8 of a mile, and finally a rise of 1 in 100 for a distance of ·56 of a mile, making a total of 3 miles for the outward journey and the same distance for the return journey. The two sets of rails being laid parallel to each other, we have to reverse the order of things in going back, so that where we had up gradients in the outward journey there are now down slopes.

We take, again, a car capable of holding 40 passengers weighing together 2·5 tons; the vehicle itself weighs 2 tons and the whole propelling apparatus half a ton. This car, when running at the rate of 6 miles per hour absorbs, on the level road. 2,764 watts or 3·76 electrical horse-power.

For simplicity's sake we take the E.M.F. at 200 volts, and we assume it to be constant throughout the line. The generating station (engine and dynamo) we place as near to A, the starting point, as convenient, with the

In the Return Journey, B *to* A.

2956·8	feet, down 1 in 100	736	3·68	1·0
4224	„ up 1 in 50	6889	34·44	9·36
5280	„ level line	2764	13·82	3·76
739·2	„ down 1 in 30	0	0	0
1056	„ level line	2764	13·82	3·76
1584	„ up 1 in 75	5520	27·6	7·5

CURRENT AND TIME.

Outward.		*Return.*	
3 min.	Amp. min. 0	5·6 min.	Amp. min. 20·6
2 „	„ „ 27·64	8 „	„ „ 275·52
1·4 „	„ „ 33·75	10 „	„ „ 138·2
10 „	„ „ 138·2	1·4 „	„ „ 0
8 „	„ „ 0	2 „	„ „ 27·64
5·6 „	„ „ 136·81	3 „	„ „ 82·8

Average $\frac{336·39}{30}$ = 11·21 amps. Average $\frac{544·76}{30}$ = 18·158 amp.

Thus, in the double journey, if made in 60 minutes, the average current expended by the motor should be 14·68 ampères.

The heat waste caused through the conductor resistance varies with the square of the current strength, and in order to ascertain its average value we have to take the time into consideration.

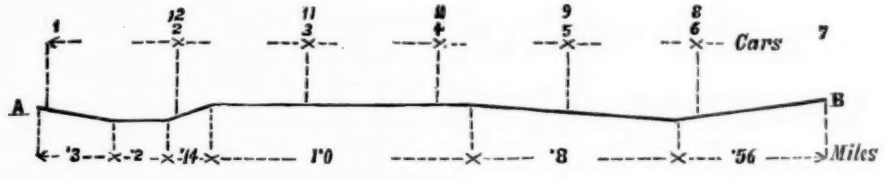


FIG. 8.

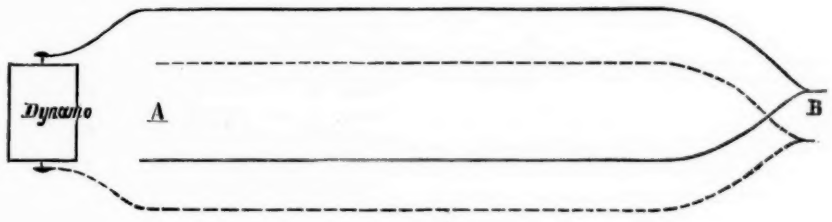


FIG. 9.

copper conductors, as indicated in the diagram (fig. 9), where the thick black line represents the copper rod and the dotted lines are the return leads, formed of the rails themselves.

If this car is to run at a uniform speed of 528 feet per minute, then we have to provide it with a motor capable of utilising 12·8 electrical H.P. when on the stiffest incline. When travelling down hill the vehicle will move by gravitation alone, and the average power absorbed during the journey will be 3·99 H.P. The resistance to traction is taken at 30 lbs. per ton, therefore this car will only run down the incline of 1 in 75 at its normal speed without expending electric energy. Down the steeper grades we have to apply the brake, and down the lesser gradient a small amount of current will be required.

If it were possible to construct a motor which could adjust itself exactly to the load, working at a constant speed and with a constant efficiency, then the power absorbed would come out as follows:—

POWER AND CURRENT RATE.

In the Outward Journey, A *to* B.

1584	feet, down 1 in 75	0 watts	0 amps.	0 H.P.
1056	„ level line	2764	13·82	3·76
739·2	„ up 1 in 30	9421	47·1	12·8
5280	„ level line	2764	13·82	3·76
4224	„ down 1 in 50	0	0	0
2956·8	„ up 1 in 100	4887	24·43	6·64

We get thus in the outward journey, during

3 minutes	... ...	$0^2 \times 3$
2 „	... ...	$13·82^2 \times 2$
1·4 „	... ...	$47·1^2 \times 1·4$
10 „	... ...	$13·82^2 \times 10$
8 „	... ...	$0^2 \times 8$
5·6 „	... ...	$24·49^2 \times 5·6$

} × ·4

and during the return journey

5·6 minutes	... ...	$3·68^2 \times 5·6$
8 „	... ...	$34·44^2 \times 8$
10 „	... ...	$13·82^2 \times 10$
1·4 „	... ...	$0·0^2 \times 1·4$
2 „	... ...	$13·82^2 \times 2$
3 „	... ...	$27·6^2 \times 3$

} × ·4

giving an average of 153·8 watts wasted in heating the conductors with one car on the line.

But the tramway service is to be so arranged that cars should follow each other at intervals of five minutes; we require, therefore, 12 such cars to do this. When all the cars are running together, at equal distances apart, we are at one moment using the following current rates:—

Outward.		*Return.*	
1st car down	... 0 amps.	7th car down	... 3·68 amps.
2nd „ up	... 47·1 „	8th „ „	... 3·68 „
3rd „ level	... 13·82 „	9th „ up	... 34·44 „
4th „ „	... 13·82 „	10th „ level	... 13·82 „
5th „ down	... 0 „	11th „ „	... 13·82 „
6th „ up	... 34·44 „	12th „ down	... 0 „

a total of 178·62 ampères at the instant of the above arrangement, and this represents 48·54 H.P. at the terminals of the motors; adding to this the energy wasted in the leads at this particular instant, viz., $\frac{178{\cdot}62^2 \times {\cdot}4}{736} = 17{\cdot}3$ H.P., we obtain a total of 65·84 H.P. at the terminals of the generator. No account is taken of any leakage on the line. The terminals of the motors are assumed to be arranged in parallel with the conductors.

HOWARD AND HAIG'S PRESS BUTTONS.

THIS is a contrivance designed for the purpose of reducing the cost of electric bells in small houses.

Externally it resembles an ordinary press button, but behind the ornamental boss is a cylindrical chamber, about $2\frac{1}{4}$ in. in diameter by $1\frac{1}{4}$ in. deep, at the back of which are the binding screws to which the wires are to be connected. This chamber contains the mechanism, which may be thus described :—

The press rod or button, when pushed in by the finger, depresses the head of a kind of bellows (the air within which escapes freely by a valve provided for that purpose), and at the same time carries a contact spring over one or more contact studs, separated from one another by a non-conductor. A circuit is, therefore, formed only as the spring passes over each stud; but under the pressure of the finger this is done with such slight intervals as to produce a continuous ringing of the bell.

When the finger is removed, the bellows head or piston is made to recover its normal position by means of a spiral spring, but the valve now closes, and the air being admitted very gradually, the recovery is necessarily slow.

Sensible intervals of time are, therefore, occupied in the transition of the contact spring from one stud to another; and, again, some time is occupied in its passage over the studs themselves; hence a succession of rings is obtained automatically, two, or three, or four, according to the number of intervals in the press employed. Thus, three or four separate rooms in a house are distinguished by their numerical ring; three or four more may be similarly distinguished by a bell of a higher pitch; and so on, to any moderate number.

This system renders a separate indicator unnecessary, thus saving an expense of some 30 per cent., or more, in the fitting of these appliances; it also saves the trouble of *going to look at an indicator*, which is sometimes very inconvenient. The principle, too, is capable of being applied to other uses besides domestic bells.

The sole manufacturers are Messrs. Howard and Haig, and their invention is provisionally protected.

ON TELEPHONE SYSTEMS.*

By Prof. AMOS E. DOLBEAR.

THE subject of the telephone is not so old as some other subjects that might be named, but within the past 10 years it has engrossed so much attention in the way of experiment in all civilised countries, and has been the text for so many discourses that it is hard to find anything that shall be new to such a body of listeners as I have before me. I cannot hope to add to your knowledge, and my aim will therefore be to summarise the principles that underlie telephony, and the methods that have been adopted in developing it.

I would first remark that when any physical end is to be reached, there are certain physical conditions which must be recognised, viz., the laws of matter and of energy. There can be nothing accomplished in the physical world without it. Matter always is subject to its own laws, and the relations of matter to energy are such that no transformation of the latter ever takes place except through the agency of matter. Indeed, it would be true to say that the body of physical science is made up of statements of the conditions under which energy is transformed.

We may call these the laws of nature; they are the conditions under which we live and to which we must conform, for a physical law can never be traversed. A balloon rises in the air not in spite of gravity, but on account of gravity. The pressure of steam is due to molecular impact, and if the molecular velocity be great enough, the boiler bursts. If the railroad train is to be run fast there must be no short curves in the road, for Newton's first law threatens disaster to such a combination.

Physical relations or laws then are fundamental, and every working machine works in accordance with them, whether the maker understood those laws or had them in mind or not. In the days when the commonly held theory of heat was what is now known as the Caloric theory, the steam engine worked just as it does now, and the development of the kinetic theory of gases, and a clearer understanding of heat phenomena has not affected the motion of a single molecule. Clearly, then, individual *intention* has nothing to do with physical laws involved in any piece of mechanism.

All mechanical devices embodying energy are either transformers, transferrers or governors. A furnace is a *transformer* of the chemism of coal and oxygen into heat. The boiler is a transferrer of heat to the water endowing it with greater molecular energy. The engine is a transformer of the heat energy into visible mechanical rectillinean and rotary motions, while the main shaft is again a transferrer of rotary energy to the distant room where, through the agency of pulleys and belts the transformations are chiefly such as change the character or direction of motion, converting rotary into reciprocating motion, or *vice versa*, &c. In like manner a galvanic battery is a transformer of the energy of zinc and acids with electrical energy. The leading wires are transferrers, conducting the electrical energy where it is needed, while the relay or sounder is again a transformer of the electrical energy into mechanical motions of an armature which may record its own movements, or the latter may be interpreted at once by an experienced listener. If a Morse key be put in such a circuit, it is as a controller of the transformations, and of course of the transference as well. It neither adds to nor subtracts from the energy, it simply controls it. So long as the Morse key is manipulated by hand, the electric energy available is subject to the will of the operator, only, however, in its *rate of delivery*, not as to its generation, its velocity of transmission or its transformations in the sounder. Those are the physical relations which are beyond the reach of any intention, and could not be changed by any will or wish the manipulator might have.

It is, however, possible to make an automatic governor or key which shall so control the electricity as to produce a set of signals similar to those made by hand, but this automatic device is built upon physical principles, has its own laws of working, and, *while it is working*, is not subject to any one's dictation or will or wish. If it does its work properly it is because it is made in accordance with the laws of matter and of energy, which are concerned in its working, whether the maker knew all those laws or not. It is as true for such a piece of mechanism as for a boiler injector or the governor of a steam engine. These principles or laws are simply *adopted*, not adapted; the mechanism is always *adapted* to the principles or physical laws which are to be operative, and it is right that the distinction between physical laws and the apparatus through which transformations of energy or the control of energy, are possible, should not be lost sight of, for I have known where the statement of the recognition of a physical law in the sense in which I have

* A Lecture delivered before the Franklin Institute, Friday, December 11th, 1885.

described it, has been made as a claim upon the physical law itself. The law has allowed it, and the court has awarded it.

What, then, are the physical conditions which underlie the electric transmission of speech? Speech—articulate speech—consists of sound vibrations in the air, generally of a highly complex character. The sounds themselves are partly arbitrary and partly automatic; that is, what I call a tree a Frenchman would call *l'arbre*, and a Chinaman something else. So much is purely arbitrary, but there is a difference—a physical difference between my word tree and your word tree, which no amount of painstaking on my part could make identical, the character of my voice is not subject to volition; it is as automatic as the sound of a violin or of a cornet, and that for the reason that the instrument that produces it is a physical instrument, having its own laws of vibration and resonance. The pitch may be varied, but not the quality, and so it is for a cornet or a violin. Articulate sounds are the arbitrary ones, and have no particular character like musical instruments, no particular series of harmonics belongs to speech, but articulate sound vibrations in air involve *energy*, and can only be maintained by the expenditure of energy, and any question of the transference of such vibrations from one point to another is simply a question of energy. If the distance be not too great, there may be enough energy in the vibrations in air to affect the auditory nerve of a listener, and no transformation will be needed. If the sound waves are prevented by a tube from spreading spherically in space, the energy will not be so wasted, and the sounds be heard at a greater distance, but there is a limit there, and if speech is to be rendered at a greater distance, apparatus for transformation and transference must be employed. If electricity is to be used, then the relations, if any, between sound vibrations and electrical phenomena must be employed. We might be supposed to know that electricity quickly distributes itself in a metallic circuit, and also that a Morse key enables one to send electric pulses at will through an electric circuit. But a key that will respond to sound vibrations *must necessarily be automatic*, for no hand can move with the rapidity and variety of sound vibrations. When sound vibrations fall upon any surface they impart a portion of their energy to it, and cause it to vibrate in a similar way. One may whisper close to a closed door, and be heard by one whose ear is against the other side of the door. The smaller and thinner the surface against which such sound waves spend themselves, the greater will be the amplitude of the movements. Let such a surface, capable of responding to any sound vibration, be provided with freely moving electric terminals, so that every vibration shall send into the wire a corresponding electric impulse or wave, and we have a device that will do for speech in an automatic way what the Morse key will do when manipulated by hand, namely, vary the strength of an electric current in the circuit in accordance with certain arbitrarily chosen symbols. Such a device is now generally called a transmitter, but in reality it is an automatic governor, as its function is to control an electric current operated by the variable energy of sound waves. So far as the apparatus described does what has been said, we have an electric circuit in which the electric energy is a variable quantity depending upon the vibratory movements of the tympanum, and this may be from the maximum quantity which the provided conditions permit, to nothing if the current be entirely broken.

With the Morse key, this range is reached for each signal; with the other, the range cannot be so great without danger of omitting some of the vibrations that constitute the sound. The sound vibrations in the air are a series of continuous waves so long as the sound is being produced. If the velocity of sound in air be, say, 1,125 feet per second, and if a sound of any kind be produced for, say, one second, then the first wave will be 1,125 feet from the last wave, and between them will be an unbroken series of similar ones. If such a series had acted upon the terminals of the electric circuit, the same unbroken series of electric waves would have been produced.

WHAT IS A SYSTEM?

A system is a series of steps or processes employed to attain some end or accomplish some purpose. Some things may be done with a single movement, yet there are few things that may not be done in more than one way. A tree may be cut down with an axe, or sawn down either by hand, or by a circular saw run by steam, or it may be burned off by a platinum wire made red hot by electricity, or it may be gnawed off by beavers.

If time is to be kept, it must be by some *uniform movement*, which may be secured by a pendulum or balance wheel, each in train with a set of gears and a weight or a spring. The end attained is the same, but the steps are different, and these may properly be referred to different systems or methods. Uniformity of action is the physical, necessary condition for time-keeping, but uniformity of action is not a method of time-keeping.

If the early maker of a pendulum clock had said: "I have discovered that in order that time should be kept, it is necessary to have a uniform, mechanical movement, and I have invented a pendulum to effect this; I, therefore, claim the method of and the apparatus for time-keeping;" if some patent office had granted such a patent, and if the courts had upheld the claim, the case would be paralleled by the celebrated fifth claim of the famous telephone patent of 1876. It might be true that no one had stated the condition so tersely before, yet the Clepsydra embodied the proposition and astronomers had predicted eclipses on the basis of uniform motion for time-keeping for thousands of years before.

Morse proposed a telegraphic system consisting of a battery, a key, a transferring wire, and an electro-magnet, with a movable armature, which should record its movements. Not one of the steps was original with him. He invented neither battery, nor key, nor conducting wire, nor electro-magnet, but he combined these in such a way as to produce valuable results, at distances which had not been reached before. Bain proposed a telegraph system, in which a battery, a key, a wire, and an electro-chemical instrument were employed. Neither of these steps did he invent. The differences were, briefly, that where Morse employed magnetism and its mechanical relations, Bain employed chemism and its optical relations. One embossed paper, the other made a blue mark upon it. But the differences were deeper than this, for the battery-power needed to do the work was much less in Bain's than in Morse's, and, moreover, there is a limit to the speed with which an armature of a magnet can move, and, therefore, a limit to its telegraphic speed, but there is no such limit to the speed of such chemical reactions. Indeed, the only reason I ever heard for the abandonment of Bain's system was its unnecessary delicacy. In each of these systems, the electricity which was to do work was fitted at the transmitting end for the work it was to do at the receiving end, and the movements, of whatever sort, at the receiving end, had corresponding motions of the key. Then there was the dial system of telegraphy, wherein a finger moving round a dial caused a similar movement of a finger about a receiving dial. In each and all systems, it was recognised as a physical necessity that if electricity was to do a certain work, it must be fitted for it at the transmitting station. If dots and dashes are wanted, they must be made at the transmitting station. The wire is employed simply as a transferrer, not as a transformer, and if it has such a transforming property, its efficiency as a conductor is so much impaired, the amount of energy it can transmit in a given time is less, and the characteristics of the energy are more or less effaced.

It is not, then, singular to the telephone that the characteristics of the energy needed at the receiving end should be given to the electricity at the transmitting end, but on the contrary, it is the physical condi-

tion that underlies all electrical apparatus whatever and depends solely upon the laws of the transformation and conservation of energy, and must be conformed to, as any other laws must. To give a new crook to a magnet, or vary the relations of mechanical details in a transmitter, and call them a new system, is, to me, as ridiculous as it would be to paint the parts some different colour and then christen it a new thing. That is not saying but that such changes may be improvements, but so long as the series of changes is precisely the same, from beginning to end, in both transmitter and receiver, I do not recognise the appropriateness of calling anything a new system. A different set of changes, involving different transformations of energy, different laws requiring different apparatus, I do call a different system, and these must belong to both transmitter and receiver.

In conformity to this, what are the possible ways by which sounds of any sort may be electrically transmitted and reproduced at another place?

(I.) As to the so-called transmitter, or the device for fitting the electric energy for the work it has to do. There are two ways in which electric energy in a given circuit may be controlled. (I.) By varying the resistance, and (II.) by varying the electromotive force in it. If there be any third way, I do not know of it. If, then, the energy of sound waves can be so utilised as to vary the resistance in an electric circuit in conformity with the varying phases of the sound waves, we shall have one method, and as there is to be no transformation, it is evident that the action will be wholly mechanical, for the sound vibrations themselves are but mechanical movements in an elastic medium, and if there be no transformations, the last term of the series will be mechanical in the same sense.

If sound energy can be made to vary the electromotive force in a circuit, without changing the resistance in the circuit, then we shall have another and a different kind of transmitter. The discovery of magneto-electricity makes it possible, and some of the very first magneto-electric experiments pointed out the way, namely, the generation of electric currents by means of the motion of the armature of a magnet.

(2.) As to receivers. The range of possible receivers is not restricted as is that of transmitters and a great number of ways of utilising the electrical energy that has been properly adapted by a transmitter have been devised. It will be well here to recall the various effects which electricity is competent to produce.

(I.) Electricity is competent to affect a magnet, which tends to set itself at right angles to the wire through which the current flows. Ordinary galvanometers are constructed to utilise this action of electricity.

(II.) Electricity is competent to produce a magnet, and upon this property the common electric telegraph and hundreds of other applications have been founded.

(III.) Electricity is competent to decompose compound-chemical substances, as, for instance, water; and for the utilisation of this property of electricity, a common and simple one is the production of a blue mark by means of the decomposition of the ferrocyanide of potassium as in Bain's electric telegraph.

(IV.) Electricity is competent to deposit one metal upon another metal, and from this property has grown up the great industry of electro-plating.

(V.) Electricity is competent to produce heat, the highest temperature which man is able to produce at present is that in an electric arc, and is used for the fusion of refractory substances, such as platinum, gold, and steel.

(VI.) Electricity is competent to produce light, and the two systems of electric lighting, namely, that by the arc and that by incandescence, are developments of the possibilities in that direction.

(VII.) Electricity is competent to reduce the friction between bodies, and this property has been utilised by Edison in one of his telegraphic systems.

(VIII.) Electricity is competent to produce either heat or cold at a junction of metals, according as the current flows this way or that, which is known as Peltier's phenomenon.

(IX.) Electricity is competent to produce various physiological effects, and is extensively used as a therapeutic agent.

(X.) Electricity is competent to give a torsional strain to a conductor through which it flows, either right handed or left handed, according as the current is towards or away from the observer. This has been used to measure the strength of the current flowing through the wire as a kind of galvanometer.

(XI.) Electricity is competent to produce very various gaseous phenomena, and a visible motion of paddle-wheels, by the impact of gaseous molecules, as is exhibited in various forms of Crooke's tubes.

(XII.) Electricity is competent to twist a ray of light in air or other transparent medium, but this is at present used, so far as I know, only in the investigation of physical phenomena among molecules.

(XIII.) Electricity is competent to produce in the non-material substance, called ether, a certain condition, which is generally known as the electric field, a field within which various interesting phenomena are manifest, and which are at present the subject of investigation by physicists.

(XIV.) Electricity is competent to produce a noise or sound by disruptive discharge, as in the phenomena of thunder storms and on a small scale by electric machines and Leyden jars.

(XV.) Electricity is competent to produce attraction, but this phenomenon, which has been known perhaps longer than any other of an experimental electrical kind, has not been utilised to any considerable extent.

It is not improbable that there are other things which electricity will do, which I have not enumerated, or that will hereafter be discovered. It is possible to make nearly every one of these effects available in a telephonic receiver.

It is not my intention to undertake any settlement of historical matters in connection with the telephone, nor to enter upon any questions of priority, and the names which I shall employ to designate the different systems I describe, I only adopt for the sake of distinctions which exist, and these can be more easily kept in mind if so individualised, than in any other way.

Farrar, of Keene, N.H., discovered in 1851, by experiments with electro-magnets and vibrating reeds that completed and broke an electric circuit, that the

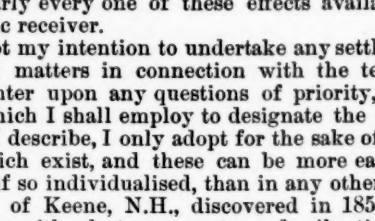


FIG. 1.

magnet was capable of responding simultaneously to several distinct series of such reed vibrations, and that suggested to him that if he could contrive to vary the electricity in the circuit by voice vibrations, as he did with the reed vibrations, that he could electrically transmit speech. He was not able to devise an appropriate transmitter, and was discouraged from the attempt by the expressed opinion of the impossibility of doing it by Prof. Silliman. He had, however, the receiver, and had proved its ability to act in the way proposed. I cannot allude to Farrar's system as complete, for the work was but half done, and I, therefore, put in the place of the transmitter the interrogation point, to indicate what was lacking.

REIS'S SYSTEM.

Nearly ten years after that, Reis, of Germany, invented the mechanism that Farrar lacked, namely, an apparatus that was capable of responding to the minutest shades of acoustic vibrations, and having an automatic attachment making part of an electric circuit, the motions of this attachment, or the electrodes, as it may be called, being governed altogether by the sound-waves in the air.

Reis made a number of transmitters, varying the mechanical details in each, but they all had in common a membrane stretched taut over an aperture, and against which sound-waves of any kind were to impinge. This membrane had fastened to its middle a thin strip or disc of platinum foil, which was connected by a wire to a binding post. Connected to

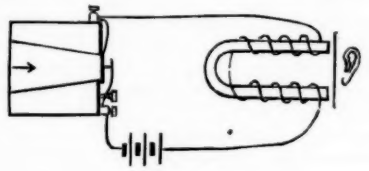


FIG. 2.

another binding post was a metal strip reaching to the middle of the membrane, where a piece of platinum wire, fixed at right angles, was so adjusted by a screw as to touch gently upon the platinum disc and so complete the electric circuit with a battery, and an electro-magnet for a receiver. The energy of the sound-waves was employed to control the electric energy in the circuit, and it was expected that any change in the one would make a corresponding change in the other. That Reis expected this, is perceived in his lecture, where he gives the curves for compound sound vibrations in air, a continuous and not a broken one, which, if it was to be transmitted and reproduced, must not have lost any of its characteristics. It is certain that he intended to have reproduced in his receiver all the characteristics of the sounds made at the transmitter. He explains the action of his transmitter as making and breaking the circuit for every vibration of the membrane, and a deal of wearisome talk has been made of late years about Reis's *intention*, one party declaring the intention to be in the function of the apparatus to transmit and reproduce sounds of all kinds with their characteristics, and they point to Reis's statement that he thus did transmit and reproduce the sounds of the piano, accordeon, clarionet, horn, organ pipes, and speech. The other party declares that Reis's intention was to make and break the circuit for every vibration, and, therefore, he could not possibly have intentionally transmitted speech, for a continuous circuit and an undulatory current are essential to do that. If, therefore, Reis did do what he says he did, it was accidentally done, and the apparatus was not working as it was intended to work. It ought to be remarked, that if the tones of the above-named instruments were reproduced, there must have been the same continuousness that is now insisted on as being essential for the transmission of speech, for the sound of a piano string is made up of a number of separate tones in harmonic series, and continuity is as much a characteristic of such sounds as of any other. But Reis distinctly says that he was able to transmit human speech, adding, "though not with distinctness sufficient for everyone," which implies, if anything, that it was distinct enough for some. Reis explains the lack of distinctness to which he alluded as being due to the fact that the higher overtones were too weak in the receiver for all to hear, not that some of them were not present at all. But that objection of a lack of distinctness was brought against the telephone of the present day. Over and over again, I have heard persons say, when first listening to a telephone that was speaking well, that they couldn't hear what was said, and I dare say everyone has had a similar experience who has worked with telephones to any extent. The fact is, that nearly everyone requires some experience with a telephone before he can make out all that is said, and Reis's audience was not made up of experienced persons. There is, however, no reason at all to doubt that Reis did transmit speech with his apparatus, for, as I have said before, the working of the transmitter is *automatic*, and depends upon the sound-waves that fall upon it, and not upon anyone's intention of how it shall do its work. Take any Reis transmitter and couple it in a circuit with a battery without anything for a receiver. Now, speak to the transmitter. Will the sound-waves vary the current strength in a proportional way? In other words, will the current be the kind known as undulatory, and one capable of reproducing the words spoken? There is only one answer to this question; there are no ifs nor buts about it. Whether they be heard or not, is another question depending upon the kind of device used for transforming the electric energy, and its degree of sensitivity, also, the acuteness of hearing of the one who listens. If an electro-magnet ill adapted to the conditions be used for a receiver, the speech might not be heard, but it would not be because the character of the work of the transmitter was at fault, but because the receiver was not delicate enough. To say otherwise, would be like denying the existence of a current of electricity in a circuit, because the needle of a galvanometer made for strong currents gave no indication of one. If it is of any importance to know whether there be a current or not, include in the circuit the most delicate galvanometer to be had. The test for the character of the working of the Reis transmitter is similar; put the most delicate receiver at hand in the circuit and listen. When such a test as that is applied, it is always found that the current from a Reis transmitter is identical with the one in common use to-day for telephonic purposes. Where this is done, however, the deniers of Reis's claim assert that the transmitter works on account of knowledge acquired since 1876, but they know better, and argue thus for commercial reasons only. Indeed, I think it proper to say here that I have conferred with a great number of electricians in various parts of the country about this matter, and there is the greatest unanimity concerning it, that Reis did invent a speaking telephone; that he used it for that purpose, and that it works in the same way as does the modern commercial telephone. A number have given me testimonials to that effect, and several who do not wish to be mixed in the controversy, express privately to me the same views precisely. The only ones that oppose it are those who have a pecuniary interest in denying it.

Reis's system of telephonic transmission consists in the employment of sound vibrations to operate upon electrodes, so as to vary the resistance at the electrodes, and thus control the current in conformity to the sound vibrations. His transmitter is more properly an automatic governor of the current, which is provided by a battery in the same circuit. His receiver consists of an electro-magnet, mounted upon a resonant case. Of these there are two varieties: One, an electro-magnet without an armature, in which the varying current changes the magnetic strength, causing a corresponding molecular rearrangement, which produces the sound in air reinforced by the case; the other, an electro-magnet with an armature, provided with a spring to oppose the magnetic attraction on the one side, and a stop screw to prevent contact with the poles on the other side. The main source of the sounds in this is due to magnetic induction upon the armature, just as in the telephone of to-day. This, too, is mounted upon a resonant case. The instrument very closely resembles a common relay, the horizontal magnet, the hanging of the armature and the recoil spring are all there, and, as might be supposed, a relay makes a tolerable receiver.

Yeates, of Dublin, placed a drop of water between the platinum electrodes in Reis's transmitter, and thus prevented the absolute break in the current to which Reis was liable; he also mounted the electro-magnet of the receiver in a better way, and so got better results. Dr. Messel, of London, who was one of Reis's pupils, told me that Reis himself placed water and sulphuric acid and sulphate of copper solution, and various other solutions, in the same place and for the same purpose. This experiment of Yeates, which is well enough authenticated for history and credence, teaches one lesson that has been overlooked so far in this telephonic controversy. It has been said over and over again, that if Reis had actually achieved the elec-

tric transmission of speech, that everybody would have heard of it, that it could not have been buried and so little known of it, because the achievement was one of the highest importance, and therefore, if so little was known of Reis's speech transmissiom, it was because

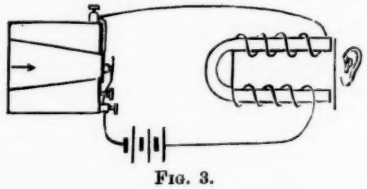


FIG. 3.

he didn't do it. But it is not denied that Yeates did it in 1866, and that it was known at the time at the University there, but it did not appear to be of enough importance to even chronicle. Silence, therefore, does not tell against Reis, but against the contemporaries of Reis and Yeates.

The grandest invention is of but little worth, except it be allied with business tact and energy. A steam engine is good for nothing without coal and stoking.

Elisha Gray, of Chicago, designed a speaking telephone and entered a caveat for it in the Patent Office early in 1876. The only difference between his plan and that which I have described, consists in the structure of the transmitter, which consisted of a metallic vessel containing a liquid conductor, the top covered with a diaphragm, carrying at its middle a wire con-

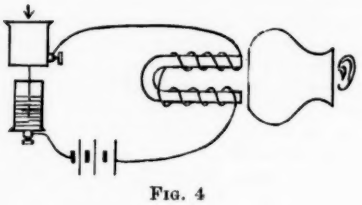


FIG. 4

ductor, reaching down into the liquid. This wire was made part of an electric current with the solution and vessel, a battery and an electro-magnet with armature for receiver. Any sound made at the diaphragm moved the wire in the solution in a corresponding way, and so varied the strength of the current by varying the resistance in the liquid. The receiver had the electro-magnet armature mounted upon a tube, which was advantageous for listening, as the sounds were thereby prevented from scattering to the degree they did with Reis's mounting. It did not differ in principle from Reis for the series of reactions from the sound to be transmitted, to the one that reached the ear, were practically the same, namely, the air vibrations acting upon an electrode varied the resistance of an electric circuit maintained by a battery, and the varying current varied the magnet's inductive strength upon the armature, causing it to move in accordance with such current changes.

McDonough, also of Chicago, about the same time had modified a Reis transmitter by making multiple platinum contacts, and lessening the liability to the disruption. His receiver was similar in structure to Gray's. This, considered as a system, is identical with Reis's.

Drawbaugh, of Pennsylvania, and Meucci, an Italian, both lay claim to the inventions of this system.

(*To be continued.*)

Bleaching by Electricity.—The *Dyer and Calico Printer* is publishing articles from the pen of Mr. W. Watson on the subject of bleaching by electricity, respecting which a short article appeared in our last issue.

ELECTRIC LIGHTING OF H.M.S. "DEVASTATION."

THE official trial of the electric light installation on board H.M.S. *Devastation*, stationed at Queensferry, and which has been fitted throughout by Messrs. Goolden and Trotter, of Westminster and Halifax, took place on Saturday last, the 6th inst. The ship is fitted with two powerful search lights of 27,000 candle-power each, the projectors and hand-feed lamps for the same being by Messrs. Latimer Clark and Muirhead; there are also two yard-arm reflectors, both containing 8 lamps of 40 C.P. each.

Internally, the lights consist of 265 lamps of 16 C.P., of the Edison and Swan type. The arrangement of the lighting was very complete, the lamps being placed to illuminate every part of the ship, even to the screw alleys and magazine light boxes, while every coal bunker in the stoke-hole was supplied with a wandering lead.

Mr. Richards, from the Admiralty, and Mr. Lane, the Portsmouth Dockyard electrician, arrived on Thursday, and a preliminary trial took place in the afternoon, which was continued on Friday, in order to thoroughly test all three dynamos and engines. The official inspection commenced at 7 p.m. on Saturday, and terminated at 10 p.m., everything working perfectly; all switches were tested, and portable lamps tried. At the conclusion of the trial Lieutenant Laborde, who represented the captain at the trial, congratulated Mr. Scott, the engineer to the contractors, on the very successful result.

The three sets of engines and dynamos, which were supplied by Messrs. Allen & Co., of Lambeth, the dynamos being Allen and Kapp's patent, worked in a most satisfactory manner.

The main switch-board, Scott's patent, engaged especial interest, and was much admired for its simplicity and compactness. It is specially arranged so that any one or more circuits can be run from any one of a number of dynamos; but no two dynamos can be put on to one circuit. On leaving the ship on Sunday afternoon, Mr. Scott was warmly congratulated by Mr. Lane, as well as by Mr. Hewitson, of the factory department, who both assembled the men of their respective departments to give him a parting cheer as he left the ship's side in the pinnace.

REVIEWS.

Electro-Deposition. A Practical Treatise on the Electrolysis of Gold, Silver, Copper, Nickel and other Metals and Alloys, with Descriptions of Voltaic Batteries, Magneto and Dynamo-Electric Machines, Thermopiles, and of the Materials and Processes used in every Department of the Art; and several chapters on Electro-Metallurgy. By ALEXANDER WATT. London: Crosby, Lockwood & Co., 7, Stationers' Hall Court, Ludgate Hill.

This work is by far the most complete treatise of the kind which has yet been published, and it is decidedly comprehensive. In the first 50 pages we have chapters on "Historical Review of Voltaic Electricity," "Electromagnetism—Magneto Electricity—Dynamo Electricity," and "Thermo Electricity," followed by a "Historical Review of Electro-Deposition." This last chapter is interesting and shows well the steps by which the important art has developed. The interest which amateurs have shown in the process of electro-deposition and electrotyping has always been strong, and much has been the consternation of *Materfamilias* on discovering her best silver spoons neatly plated with a deposit of copper by her youthful son. In speaking of Ohm's law we notice that Mr. Watt, abandoning the usual practice for no obvious reason, uses the symbol F to indicate current strength,

giving the equation as $F = \frac{E}{R}$. On page 87 we find the extraordinary statement that a dynamo having an electromotive force of 1 or 2 volts and a resistance of 0·5 ohms, may give a current of 800 or 900 ampères!

The process of nickel plating, now become so common, is naturally very fully gone into; many of the formulæ which have been devised for the baths are very complicated and, as the author states, "almost takes one's breath away."

The deposition of platinum is considered, but the writing on the subject is, as usual, of the most vague description, and it is practically impossible to judge from what the author says whether such deposition is really possible. It is interesting to note from chapter xxx. the progress which the process of electrolytic copper refining is making, a progress due almost entirely to the important improvements which have been made in dynamo machines during the last few years; the author considers, and we agree with him, that in a very short period the art of electro-metallurgy will attain a far greater extent of development both at home and abroad. A noticeable feature in the book is a very copious index. We may add that the work is uniform with Noad's well-known "Student's Text Book of Electricity," and that it contains nearly 600 pages.

Berly's Universal Electrical Directory, 1886. London: W. Dawson and Sons, 148-9, Upper Thames Street.

This is the fifth annual edition of this publication, and the amount of care exercised in its revision is evidenced by its increasing accuracy and comprehensiveness. It is an additional satisfaction to find that while this improvement has been achieved, it has been found possible by judicious rearrangement to reduce both the bulk of the volume and its price. The determination to give the names of those only who are directly engaged in strictly electrical business, is a good one, and if rigidly carried out, will add value to the book as the "Electrician's Vade Mecum."

LEGAL.

The United Telephone Company v. Donohoe.—This was an action for an infringement of a patent, which the defendant admitted, and said he had only bought a few telephones in the London market in 1880, when telephones were commonly sold, and also eight in 1881 in the same manner, that save as to these he had not infringed the patent, and that he had written to the company undertaking not to infringe the patent again. Upon this the company applied to Vice-Chancellor Bacon for judgment, and the defendant did not appear. The Vice-Chancellor gave an injunction, but refused to direct an inquiry as to damages. The plaintiff company appealed, and Mr. Moulton, Q.C., appeared on its behalf and insisted that it was not bound by the defendant's statements (though the price of a pair of telephones was £20) and was entitled to an inquiry as to the numbers sold or purchased and the damages. [Lord Esher: Suppose they turn out to be nominal?] They can hardly do so on the defendant's own statements. But the plaintiff is entitled to an inquiry as to what the damages are. [Lord Esher: As to other telephones than those admitted?] Certainly; but at all events as to those admitted. [Lord Esher: He denies any others to have been purchased, and so you cannot take it as admitted that he has purchased others.] There is a right to an inquiry on proof of a single infringement. There are 10 infringements admitted here; telephones are sold in pairs, and the price of each pair is £20; that would make £200, and we believe there have been 20 or 30. It would be idle to put us to the expense of a trial where we shall have to prove nothing. The right to an inquiry is incident to an injunction. [Lord Justice Lindley: *Prima facie* so, certainly.] The defendant appeared in person. [Lord Esher said it was absurd for parties to appear in person; they could not understand the matters.] He had no means to retain counsel or pay damages. He understood the Judge to say that there was no case for damages; he had undertaken not to infringe the patent again, and thought the action oppressive. Mr. Moulton said the company had offered to him that he should make an affidavit that he had no further instruments, and he had declined to make the affidavit. He submitted that on the admissions made the company were clearly entitled to an inquiry as to damages. [Lord Esher: Your object is not to obtain damages from this man, which you cannot, but to find out others against whom you may proceed.] That is always the object. Telephones could easily be made, and if the usual proceedings could not be taken then the company's patent might be infringed with impunity and they had no protection. [Lord Esher: Suppose you are confined to the 10 instances admitted, would it be worth while to take the inquiry?] Certainly. [Lord Esher: Why, if you cannot get the damages from him?] He says so, but we are not bound by his statements.

Their Lordships having conferred together,

Lord Esher said as the plaintiffs took the admission of the defendant they must take it as limited to the 10 instances and must take it that there were no others, so that no inquiry could be gone into others. The plaintiffs, if they liked, might take the judgment for an inquiry so limited.

Lord Justice Lindley concurred, observing that the inquiry must be limited by the admissions.

Lord Justice Lopes also concurred. The plaintiff was entitled to an inquiry as to the 10 instances, but not as to others.

Lord Esher: The plaintiffs have failed as to part, and so no costs are to be allowed on the appeal.

In re The Maxim Weston Electric Company, Limited.—In the High Courts of Justice, Chancery Division, on Saturday last, a petition presented by the above company for the reduction of its capital was heard before Vice-Chancellor Sir James Bacon. The counsel who appeared in support of the petition, stated that the company owed no money to anyone, but had lost part of its capital, which was represented in the patents it owned. It was merely proposed to reduce the nominal value of the shares from 10s. to 5s. each. The petition also prayed that the words "and reduced" after the name of the company, might be dispensed with, having regard to the fact that there were no creditors. His Lordship granted the application in the terms of the petition.

Re The Pall Mall Electric Association.—(Before Mr. Justice Chitty, Saturday.) This, the petition of a creditor which came on before his Lordship in the previous week, and was adjourned in order that some arrangement might be come to, upon the application of counsel, was again ordered to stand over for a further period.

NOTES.

Electric Lights for the Stage.—On two recent occasions, by permission of Mr. D'Oyley Carte, "Iolanthe" was played at the Vestry Hall, Anerley. In the last scene a capital effect was produced by the electric light. The fairy Queen, "Iolanthe," and three of the fairies each had on her head a light of two candle-power with a reflector behind, the whole attached to a comb fastened in the hair. The Sentry had a lamp of greater power on his busby, and the Lord Chancellor, Lord Mountarat, Lord Tolloler, Strephon and Phyllis, each wore a small hair filament lamp mounted in artificial flowers. Each actor carried a small accumulator capable of running the lamp two or three hours. These accumulators were concealed about the person, and were not in any way found an inconvenience. The accumulators, lamps, &c., were those of Messrs. Woodhouse and Rawson, who have had considerable experience in this class of work.

The Electric Lighting at the Inventions Exhibition.—The electric lighting at the Inventions Exhibition, which, it is admitted, was one of the most attractive features of the exhibition, is said to have cost nearly £40,000.

Search Lights in the Navy.—The Admiralty has ordered that in future all large ironclads belonging to Her Majesty's navy, are to be furnished with not less than four electric search lights and mirrors.

Lighting Apparatus.—The Brussels correspondent of the *Times* writes that the Belgian Engineers' Association is preparing to hold, next month, an exhibition of all the various means of illumination hitherto used.

Electric Lighting in Russia.—During a grand Court ball at the Czar of Russia's Winter Palace, the vast halls of the palace were illuminated by electricity.

The Spiel Petroleum Motor.—We have ourselves had an opportunity of seeing this engine (illustrated in our other columns) in operation, and can testify to its satisfactory performance. There should be a great future for motors worked on this principle.

A New Filament.—The Vitrite and Luminoid Company has been formed in New York, under the management of Mr. Theo. Mace, for the manufacture of what is known as the White incandescent lamp, but in the construction of which an entirely new departure has been made, a filament of a substance termed "erdite," a metalloid, being substituted for the ordinary carbon filament. It is claimed for the new filament that it does not blacken the glasses, and that its life is extremely satisfactory.

Electric Lighting in the United States.—Mr. Charles Lever has gathered the articles upon this subject which he wrote for the REVIEW, into pamphlet form, and we may safely commend the publication to those electricians who have not already read the articles in our pages, for it contains much that is original and interesting.

Electric Lighting in America.—The large number of electric light companies constantly being incorporated, says the *American Engineer*, shows the rapidity with which electricity is popularising itself. In one day the following companies were recently incorporated at Albany, N.Y.:—American Illuminating Company of New York, capital $300,000; American Illuminating Company of Brooklyn, capital $100,000; American Illuminating Company of Harlem, capital $100,000; American Illuminating Company of Yonkers, capital $30,000; American Illuminating Company of Long Island City, capital $30,000; American Illuminating Company of Newburg, capital $30,000; American Illuminating Company of Cohoes, capital $30,000; American Illuminating Company of Syracuse, capital $30,000; American Illuminating Company of Watertown, capital $30,000; American Illuminating Company of Ogdensburg, capital $30,000.

The Jablochkoff Company.—Last Friday, the 5th inst., there was a meeting of the creditors of this company at the offices of the liquidators, Messrs. Spain Brothers & Co., to receive the not very gratifying intelligence that they did not expect to be able to pay *one penny* in the £. We are indebted to a correspondent for the information which follows. The capital of the company was £195,000; £100,000 in fully paid up stock went to the promoters, £55,000 in cash was paid for patents, and £40,000, in addition to £11,000 owing to the creditors, has been expended in the "operations" of the company. Shortly before the liquidation the whole assets of the company were mortgaged to some of the directors for £4,200. Three of these mortgagees are directors of the new company, to which the patents, plant, stock, &c., of the old company were sold for £6,200. We believe these gentlemen took their £4,200 in the new company in shares, and the £2,000 they paid the liquidators in cash has been spent in liquidation expenses and in "protecting the interests of the company until the new company purchased." No balance sheet was produced, and the various points had to be elicited by questions from the creditors.

Work for the Unemployed.—Lord Thurlow, at the meeting of the Anglo-American Brush Electric Light Corporation on Wednesday, stated that he had made a calculation which showed that the passing of the proposed amendments of the Electric Lighting Act of 1882 would provide work in London alone for upwards of three years of more than 10,000 men, at an expenditure of £6,000,000 sterling. Lord Thurlow surely does not expect to see such a scheme immediately realised: what then is the object of raising hopes which may not be fulfilled for generations to come?

Electric Lighting in Oxford Street. — Messrs. Haywards, an old-established lace firm in Oxford Street, are having their premises fitted with the electric light. The installation, which is to consist of 1 arc and 120 incandescent lights, has been entrusted to Messrs. Craven and Elworthy.

The Electric Lighting Act.—It is stated that had the late Conservative Administration remained in power, Mr. Stanhope, the President of the Board of Trade, would have introduced a Bill for the amendment of the Electric Lighting Act of 1882, extending the period before the compulsory purchase clause would come into operation from 21 years to 40 years. Lord Rayleigh's proposed Bill, we believe, excludes this compulsory purchase clause altogether, on the ground that the gas industry was not at its outset hampered by any such restricting condition.

"The Electric Light in Workshops."—Mr. Charles Lever has published a pamphlet with this title, which he prefaces with the remark that it is not intended to instruct electricians; but rather to give engineers and others having large workshops some information in regard to the development of the arc lamp, for he thinks there is no form of artificial illumination which so well fulfils the requirements of workshop lighting. We think it will be found to admirably suit the purpose for which it is intended.

Electric Lighting in Milan.—The electric light installation in Milan is now probably the largest of the kind in the world. At the end of last year there were in use five boilers of 164 horse-power each, and six dynamos of the Edison "C" type, equal to a capacity of 1,000 16-candle-power Edison lamps each. This has now been increased to six boilers of 164 horse-power each, and two new dynamos, besides a small dynamo equal to 400 lamps, for day and night work. The total number of incandescence lamps at present in use amounts to nearly 8,000, besides which there are over 70 arc lamps at work, and 30 more in course of installation.

Skating Pond Lit by Electricity.—During the skating season the large loch at Cambuslang, near Glasgow, was brilliantly lighted by means of three Crompton D D arc lamps, of 3,000 C.P. each, supplied by current from a Crompton-Bürgin machine. The loch was crowded each evening, and as the skaters glided by under the rays of the powerful lamps, the scene was gay and picturesque in the extreme. The lighting was carried out by Messrs. Henry Bennett & Co., of Glasgow, and we may mention that since this firm first added the electric light department to their business—more than six years ago—they have each year lighted up one or other of the skating ponds in the neighbourhood of Glasgow, and always with the most gratifying results.

Electric Lighting at the Edinburgh Exhibition.—Messrs J. D. F. Andrews and Co., of Glasgow, have been allotted the lighting of a large portion of the International Exhibition to be held in Edinburgh in the coming season. They will put in 34 Andrews arc lamps supplied with current from two Andrews patent dynamo machines. One powerful Andrews arc lamp will also be erected on a mast 80 feet high, in the court yard of Old Edinboro'. The other lights will be distributed throughout the machinery and motion departments of the exhibition.

The Bell Telephone Patents. — The New York *World*, whilst approving the decision of Secretary Lamar to recommend the Government to commence suit against the Bell patents, counsels the Attorney-General to get rid of his large holding of rival telephone shares, asking him whether he considers his ownership of this stock is calculated to raise the highest standard of official honour in public life.

The Telephone in Scotland.—Mr. A. R. Bennett last week attended a meeting at Dunfermline to advocate a scheme for connecting Glasgow to Dundee *viâ* Falkirk, Stirling, Alloa, Dunfermline, Burnt Island, Kirkcaldy, and Cupar, and to that end the opening of an exchange at Dunfermline. Promises of support were given by the Provost and others, and there is every probability of success.

The Plymouth Telephone Exchange.—The Three Towns Telephone Exchange at Plymouth has received some important additions of late to its list of subscribers. The Mayor has had his private residence connected, but an addition which will act as a convenience to a very large number of persons is that of the Plymouth Club, whose members can now communicate with any member of the exchange. The "call" offices at Plymouth, Mannamead, and Devonport are not made use of so generally as might be wished, but this is probably owing to the advantages attending them not being sufficiently well known. The exchange now numbers nearly one hundred members, and it has been suggested that there should now be an extension of the hours during which the exchange is open, as it is considered that this would result in many private residents becoming subscribers, so as to be able to converse with their friends during the evening after arriving at home from business. This would be a great benefit to medical men, in frequently obviating the necessity for a second visit. The expense attending the extension would not be considerable, and we have no doubt that the company, willing as it always is to meet the requirements of the public in every possible way, will see what can be done to carry out the suggestion.

Telephonic Communication for the Plymouth Police Stations.—The Watch Committee of the Plymouth Town Council has decided to recommend that an agreement be entered into with the Western Counties and South Wales Telephone Company with the view of affording communication by telephone between the central and branch police stations. The importance of this recommendation is such that it can only be a matter of wonder that it was not thought of before; but probably the recent disastrous fire has had the effect of quickening the faculties of the local Conscript Fathers.

Cable News.—We notice that the ss. *Silvertown*, and the ss. *International*, belonging to the India Rubber, Gutta Percha, and Telegraph Works Company, of Silvertown, have returned to the Thames. The first named vessel has been engaged in laying, under contract with the French and Portuguese Governments, telegraph cables along the West Coast of Africa. The system now extends to Conakry, a French settlement, some 80 miles to the north of Sierra Leone. Among the sections laid during this last expedition was a cable from the Cape Verde Islands to the West Coast, thus duplicating the communications. Cable, for the continuation of the undertaking under contracts with the same Governments, is being rapidly manufactured at Silvertown, and it is expected that within a very short period the company's ships will again leave the Thames for the West Coast. Meanwhile, the ss. *Buccaneer*, is actively engaged in sounding along the coast, and has already prepared the way over a considerable portion of the route. We hope on a future occasion to lay before our readers a more detailed account of this important enterprise. The ss. *International* has been engaged with the ss. *Dacia*, in laying cables for the Indian Government in the Persian Gulf. The successful completion of this work has already been noticed, and judging from the tone of official reports, we must congratulate the Silvertown Company on the manner in which the work has, from first to last, been executed.

Saved by the Commercial Cables.—The *New York Herald* of January 30th, contained the following:—"Communication between Europe and this country would have been entirely interrupted for many hours yesterday had it not been for the Mackay-Bennett direct New York cable *viâ* Coney Island. All of the cables of the old lines were working slowly and unsatisfactorily. It would be impossible to estimate the extent of the inconvenience and loss which would have resulted to the financial and business world had communication been entirely closed during Stock Exchange and business hours."

The Cable Record Beaten.—According to the *New York Herald*, one of the leading firms of arbitrage brokers in New York sent a message on the morning of the 28th ult. from the Stock Exchange office of the Mackay-Bennett Cable Company to London. The business referred to in the message was transacted, and the answer received in New York in the space of *six minutes*; the quickest time on record.

Telegraph Revenue.—The receipts on the telegraph service from April 1st, 1885, to February 6th, 1886, amounted to £1,480,000, against £1,490,000 received from April 1st, 1884, to February 7th, 1885.

Almanacs.—We have this year received the following almanacs:—"The Engineers' Almanac," compiled by Mr. Edwin Bennett, manager to Messrs. Pfeil & Co., which contains a great deal of information relative to the construction and launching of notable ships; one from the Lancashire and Cheshire Telephonic Exchange Company, containing cuts of telephonic instruments, and information interesting to intending subscribers to the exchange; and an effective advertisement almanac from Messrs. Hudswell, Clark & Co., through their London electrical agents, Messrs. Heap and Stuart.

The West End Riots.—Mr. Eric Stuart Bruce, M.A., well known to our readers as the inventor of a balloon-signalling system, was among those who were interfered with by the riotous mob at Hyde Park Corner on Monday. Mr. Bruce was in a hansom cab with his wife, when a large jagged stone, which must have been brought some distance, was hurled through the window, covering the occupants of the cab with broken glass. They experienced a narrow escape from serious injury, and Mr. Bruce writes to the *Times* that he thinks it showed a want of foresight and vigilance in the police authorities not to have taken extraordinary precautions, seeing that a breach of the peace had been threatened.

Lighting up a Thighbone.—An interesting surgical operation was recently performed at the New York Post Graduate Medical School, in which electricity played a very important part. Disease was suspected in the hip of a young man of 22, and the doctors introduced a small drill, or electric-osteotome, into the bone, gradually with its aid cutting away the diseased portions, in order to see which, a tiny electric lamp, no larger than a pea and with a filament as fine as a hair, was placed in the hole in the bone and "flashed up" at intervals of a few seconds, the filament being so fragile that it could bear the current only for an instant at a time. It is said that the light made the interior of the bone as clear to the eye as if it were laid open on the dissecting table.

Committal of an Electrician.—Charles Stewart Cochrane, the American electrical engineer against whom the charge of forgery and personation was a month or two since brought, was on Monday sentenced to 18 months' imprisonment with hard labour.

A Disclaimer.—The Electric Apparatus Company, Limited, of Queen Victoria Street, asks us to state that it has no connection with a firm in Queen Victoria Street which advertises the sale of a portable reading lamp. The company has had several applications for this lamp and wishes to correct any erroneous impression that may have been created in the minds of the public.

Tenders for Electric Lighting Wanted.—Messrs. Elder, Dempster & Co. advertise for tenders for the electric lighting of their offices at 14, Castle Street, Liverpool. Tenders to be sent to 48, Castle Street. The Northfleet (Kent) Local Board desires tenders for lighting the streets of the town by gas, oil, or other illuminant. Tenders to be delivered to Messrs. Sharland and Hatten, Court House, Gravesend, by the 17th inst.

Trotter's Dioptric Glass.—Messrs. Woodhouse and Rawson have been appointed by Mr. A. P. Trotter special agents in Great Britain and the Colonies, and sole agents on the Continent, for the sale of his patent dioptric glass.

Dynamo Testing.—Mr. Charles F. Heinrichs discourses in the current number of the New York *Electrical Engineer* on the tests and efficiencies of dynamo-electric machines. He thinks that the most accurate results can be obtained with such a transmission dynamometer as that of the Royal Agricultural Society, in conjunction with a Prony brake. He concludes a long and interesting article by suggestions as to what should guide a committee of experts in making awards.

The Franklin Institute Tests. — A considerable amount of correspondence on this subject is to be found in the columns of the New York *Electrical World*. Mr. Heinrichs, who started the discussion by throwing doubts upon the accuracy of the horse-power measurements made with the Tatham dynamometer, comes in for severe criticism from Prof. Marks. of the Franklin Institute, and Mr. Geo. B. Prescott, Jun., of the Weston Laboratory, Newark, N.J. This latter gentleman, who writes at great length, has not yet learned the art of making the "retort courteous," and he goes out of his way to make personal allusions which are not arguments.

Alternating Currents.—Mr. Max Deri deserves much credit for his endeavours to show that alternating currents are, after all, more sinned against than sinning. His lecture, the first portion of which appears in our other columns, forms an interesting addition to the writings on alternating currents.

Lecture.—Mr. J. Jerritt, of the Society of Telegraph Engineers, gave an interesting series of experiments in electricity before the members of the Miners' and Mechanics' Literary Institution, St. Agnes, Cornwall, about a fortnight ago. Mr. Jerritt has kindly consented, at a future date, to give an entertainment on a larger scale in aid of some deserving local fund.

The following letter written to the *Cornishman* of January 30th, will give some idea of the subjects dealt with by Mr. Jerritt :—Deer Maister Editur,—Aw, my, wonders wull nevver cese! We've hed some friteful doens heer—for St. Ann's: iss, gashley things do happen now-a-days, fur I seed thet up to Menhennit theer's a poor wummun hev had three childern all to wance! I spose she'll git three suvverins from the Queen 'pon her thrown. And theer's a gashley man heer to. He do belong up to post-office, and was up to our reading-room, and fritened haalf the men and wummen out ev theer lives the other evvenin. I, and Josey, and the boy Tom (down Dirty pool) ded'nt think theer was no harm to go and see un, or we shud nevver hav gone. I wesh I hed'nt, for the cow had calf while I was away and Goorge was poorly, semmin, and cud'nt tend ur. Howsomevver we cum up, and seed un long side ov Docter. A long slivery chap a was to, clean shaved all but his stauche, and up to enny wickedness. Thet es so fur as we ken see, for the table avore un wos covvered with aal kinds ov instrummints an things thet seemed like the fire enguns they had in to Truraw to Maister James place, when a was burnt down, and t'owld things then wud'nt skit t'all. Howsome ever Dokter get up and sed few wurds for un, and then ee begin. Ee turned round and pecked up poker frum the graite, and stick un pun back ov a cheer, lor! t'was clevver to make un bide thare, as won es a dun that ee rubbed bit broun paaper under es arme and held un fore to the poker, and tha gashly owld thing cum arter un, and vallod down pon planchen and was boughed uncommon: sure I don't knaw what Maister Sam do think bout et. As soon es ee dun that he shawed what a called the elektrik magnit, ee hed pounds of filins from down Foundery and bit paper, an put this magnit under an maade they filins march bout like riggiment sodgers as was down Camberne for lecshun. Next he shawed elektrik lite, twas a raal lamp weth no oil or weck, an a put a cupple ov copper wires to un an set un all avire. Then we had telegram all round tha world and whot ee called galvanec machine, by shoks given how they chaps as clinched they wires screeched, but this man tuk care not to howld on hisself to they. Then a hed a little bell, morn a fathom away from um, and he put his hand down pon the table and ring un to: I was getting frightened, I was: and then, my lor, he fired of a grate cannun to, and sed twouldn't frighten us, but ded you, and smilled bad just like they that fire at craws and kill pigguns. Iss sure, smell powder was bad, and we boys back behind was glad enough to see Maister Konjurer set down. Well, sir, Maister Dick an Rejayster said nice things about un, and so ded we, cause we dednt like to say nothin else, an then he took his things away. I do heer ees goin to do liken agen, but I shaant go, tes to gashley: a man that cud do that wud rob a bank. I daresay that I'll rite and tel ee somethin bout wot he do do next time, ef I ken make up my mind to go an see un.—Yours respeckfuly, JAN TREGURLA.—*P.S.*—After aal I hav not told ee Maister Konjurer's name: tes MAISTER J. JERRITT, and he do cum from Plemmoth.

Electric Speed Indicator.—Writing to the New York *Electrical World*, Mr. G. B. Prescott, jun., says :—"An ingenious speed indicator recently devised by Dr. Th. Horn, of Leipsic, Germany, and described by the inventor in a late issue of the *Electrotechn. Zeitsch.*, is the subject of an interesting note in The *Electrical World* of December 19th, 1885. This note is reprinted in the January 1st number of the London TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW. The instrument referred to is based on Arago's experimental demonstration (1824) that a revolving copper disc causes a magnetic needle placed above it to rotate in the same direction. A speed indicator acting upon this same principle was invented by Mr. Edward Weston in the latter part of the year 1882, and is the subject of U.S. patent No. 277,179, granted May 8th, 1883. The only difference between Dr. Horn's recently invented indicator and the indicator patented by Mr. Weston several years ago is that, whereas in the former instrument the disc, or rather its equivalent, the ring revolves, and the directive force of the needle is obtained from a magnet, in the latter instrument the needle revolves and the directive force of the disc is supplied by a spring."

The Proposed Trans-Pacific Cable.—The *Colonies and India*, in an editorial upon this subject, says :—"We have no information as to the representative character of the gentlemen who are moving in the matter of the proposed Trans-Pacific Telegraph Cable, but it is probable that the movement has originated in Queensland. In a recent speech in the Legislative Assembly of Queensland, Sir Thomas M'Ilwraith drew attention to the existing telegraph rate of 10s. 10d. per word, which he characterised as 'monstrous,' and after deploring the fact that Queensland was not represented at the late Telegraph Conference at Berlin, he went on to advocate the construction by Queensland of a 'line of her own,' pointing out, however, that the difficulty lay in the hopelessness, if not the impossibility, of reducing the charge between England and India. From this point of view it is obvious that the best way to meet the difficulty is to adopt an entirely different route, and the best that could be chosen is that *viâ* North America. The Atlantic cable companies would no doubt be glad to secure an accession to their present business by agreeing to take through messages to and from Australasia at a reduced rate, and in that event the monopoly of the Eastern Telegraph Companies would be broken down, and telegraph rates to Australia would be brought to a reasonable figure."

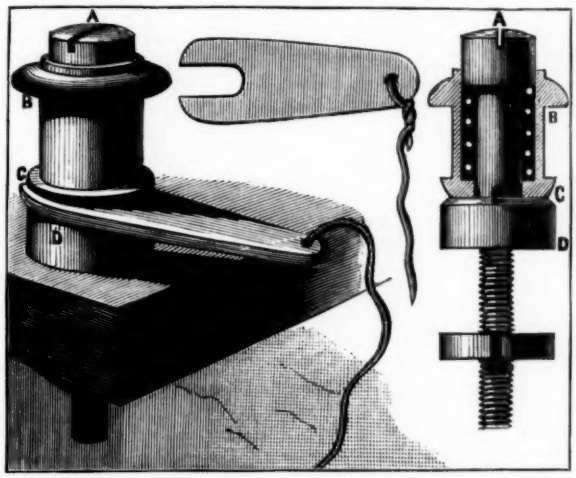
Long Electric Light Circuits.—Writing to the New York *Electrical Review*, Mr. J. R. Johnston states that the Rock Island County Brush Electric Light Company has at Rock Island, Ill., a circuit 15 miles long, operating 50 arc lamps of 2,000 C.P. each. The line or circuit is arranged in two divisions and operated by one No. 8 Brush dynamo, either separately or jointly, as circumstances require, each division having a switch board at or near the dynamo. One division is called the tower circuit, comprising 11 towers 132 feet high. This circuit is constructed of No. 6 wire, Stubbs gauge, and carrying 25 double lamps. The other division is called the store circuit, and on this are 25 single lamps. The dynamo is driven by a walking-beam engine of 45 horse-power, making about 60 revolutions per minute, with countershafting that gives the armature a speed of 750 revolutions. This plant has been in successful operation for three years. It has also been a success financially.

Re Andersen's Formulæ.—If the correspondent who writes us upon this subject, and signs himself "Ohm," will send us his name and address (not for publication) we will insert his communication. We cannot publish anonymous contributions.

Type-setting by Electricity.—Mr. J. E. Munson, a stenographer, of New York, is said to have invented a machine for setting type by means of electricity. According to the description in the New York *Sun*, a tape is punched in a manner similar to the punching of the tape of a telegraph instrument, and this tape is placed on a roller in the type-setting machine, and passes under a row of 10 steel fingers. The roller is connected with a battery. As the tape passes over the rollers the fingers find the rows of holes and drop into them. Each finger is connected with a magnet, and each magnet with one of 10 narrow steel plates that keep a series of pointers from reaching the type in the reservoirs. When a row of holes in the tape representing a character passes under the fingers, the fingers above the holes drop down on the cylinder, a current of electricity passes to the magnets, and the magnets, thus influenced, draw such a combination of the little plates from one side of their normal resting place to the other as will allow the pointer opposite the required letter to reach the type in the reservoir and force it into the shoot leading to the "stick" which is to hold it. The impulse given to the pointers is simultaneous with the action of the magnets. When the tape passes on, the plates and pointers return, until another row of holes in the tape is reached, and then the action is repeated.

The Divining Rod again.—A correspondent sends us the following cutting from a New Zealand paper, which he thinks may amuse our readers :—"A gentleman from the West Coast waited at the Christchurch Press office, in December last, to exhibit a new electrical divining rod. For this modern invention all the powers, and more, of the ancient magical rod in detecting gold anywhere were claimed. The rod was an arrangement of wire cased in leather, something like a huge spur, the divining rod being nicely balanced across the half-circle so that one half was outside and formed what might be termed the rowel. Attached were bottles containing gold and electricity. The gentleman from the West Coast tried the rod with a representative of the Press on some gold and silver coins, and sure enough the rod dipped over the gold coin infallibly. The Press representative tried it, and he also succeeded, as the rod "dipped" over the gold. But the representative of the Fourth Estate was not quite satisfied, so he rolled three sixpences and a half-sovereign in paper and laid them about the room in positions unknown to the gentleman from the West Coast. The divining rod was tried, but here it was decidedly at fault, for it did not respond to the gold, but did to the last of the silver coins. The gentleman from the West Coast departed, with a request that nothing should be written concerning the matter, as it was evident that if the rod could not detect gold when rolled in paper, the claims of its inventor that it would "dip" when walking over a spot on any hill where gold was concealed in the earth, were open to question."

M. De Combette's Automatic Terminal.—Ordinary terminals with a screw or a hole present certain inconveniences in cases when numerous experiments are made, or when it is requisite to be able to rapidly substitute one apparatus for another, to alter wires, &c. This terminal, which we reproduce from *La Nature*, has a central piece, A, resting upon the base of the apparatus by a flange, D, and a movable portion forming a hollow cylinder provided with a milled head, B, at the upper and with a flange, C, at the lower end. An internal spring keeps the flange, C, pressed strongly against the base. By resting the thumb upon A, and taking the milled head between the index and middle



fingers, we raise the movable cylinder. We can then insert between C and D a looped wire, or a slotted plate previously soldered to the wire to be connected. On releasing the terminal the spring grips the wire or plate, and ensures a sufficient contact when the parts are quite clean. This terminal may be used for experiments at meetings and lectures for medical, telegraphic and telephonic apparatus, &c., and in all cases where we require to establish communication frequently and rapidly between electric apparatus.

NEW COMPANIES REGISTERED.

Standard Time and Telephone Syndicate, Limited.—Capital £20,000 in £1 shares. Objects :—To acquire and work inventions for the regulation of time by electricity or otherwise, for the transmission, accumulation or dispersion of electric currents, and for the utilisation of electricity. To manufacture telephones and to establish telephone exchanges and to manufacture electric, magnetic and pneumatic apparatus of all kinds. Signatories (with one share each) :—C. E. Haefling, 143, Sandringham Road, Dalston ; J. Negus, 38, Roseberry Place, Dalston ; J. A. Hilliard, 75, Cornhill ; E. Shirley Parker, 75, Cornhill ; S. H. Newman, 7, St. Quintin's Avenue, North Kensington ; J. Wallis, East End, Finchley. The direction of the company will be vested in managers who are to be appointed at the first general meeting. The remuneration of the managers will be such sum as may be voted at the annual general meeting. Registered 6th inst. by Stretton and Hilliard, 75, Cornhill.

Gas and General Works Company, Limited.—Capital £10,000 in £1 shares. Objects :—To construct and maintain public works of all kind in any part of the world, including railways, tramways, harbours, docks, gas works, telegraph and electric works, and works for the supply, use and application of electricity

for light and power. Signatories (with one share each): James Clegg, W. Harwood, Wm. Hoyle, A. Clegg, A. S. Marshall and P. Clegg, all of Accrington, Lancashire, and J. H. Hole, of Cheetham, Manchester. Directing qualification £100 of capital. The signatories are to appoint the first directors. Registered 8th inst. by Mr. J. Chamberlain, of 5, Trafalgar Terrace, Moseley, Lancashire.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES

Standard Time and Telephone Company, Limited.—At an extraordinary general meeting of the members of this company, held on the 18th ult., at 19 and 21, Queen Victoria Street, it was resolved to wind up voluntarily. The resolution was confirmed on the 2nd inst. and duly registered on the 6th inst. The company was incorporated on the 26th July, 1882, with a capital of £100,000 in £1 shares. The only return filed is made up to 24th November, 1882, and shows that 20,085 shares were taken, and upon these £18,057 had at that date been paid up.

West African Telegraph Company, Limited.—The statutory return of this company, made up to 2nd inst., was filed on the 6th inst. The nominal capital is £1,000,000 in 100,000 shares of £10 each. 2,000 shares have been taken up but no call has yet been made thereupon. Registered office, 106, Cannon Street.

CITY NOTES, REPORTS, MEETINGS, &c.

Anglo-American Telegraph Company, Limited.

The ordinary general half-yearly meeting of this company was held at the Cannon Street Hotel, on Friday, last week, under the presidency of the Right Hon. Viscount Monck, chairman.

There was a large attendance of shareholders in anticipation of the discussion on the subject of the renewal fund, and the motion of which notice had been given, that no further additions be made to that fund with the exception of the accruing interest.

Mr. T. H. Wells, the secretary, having read the notice convening the meeting, and the minutes of previous meetings having been read and confirmed,

The Chairman said that when he last addressed them he was obliged to tell them that several, if not all, of their short cables on the other side of the Atlantic had suspended action. They were aware that, independently of the cables which carry the traffic of the company across the Atlantic, they had a regular system of cables at the other side connecting the cables with the different seats of traffic in America. He had now the pleasure of telling them that those cables, and the whole of the rest of the system, were in perfect order and working with efficiency. There was not a single mile of the plant that was not complete and in perfect order. Having said that, he was sorry he could not give them a very satisfactory account of the traffic itself. The competition still continued. The truth was, that the public, in their wisdom, had put down in the Atlantic such a number of telegraphs that at present the traffic did not afford a living to any of them; and his belief was, that it could not afford a living to any of them without one of two things occurring. One relief might, of course, be obtained by a very large increase of the traffic, but he was sorry to say that, after the experience of nearly twenty years, having tried tariffs of all sorts, high and low, they could not find that there was that elasticity in the traffic which would enable the number of cables now existing in the Atlantic to live. The elasticity of the traffic was, he thought, completely exhausted unless there was a return of prosperity and trade. The only other alternative was one the public would not desire adopted, but it was one which he had ventured to declare from that place, would be the result of the inordinate competition which prevailed—and that was, the rates must be raised. There was an old saying that where combination was possible competition was not likely to continue long, and seeing the small number of people it was necessary to bring into agreement, his belief was that the rates would be raised to a paying figure. They had been hoping and expecting that this would take place for some time, and even now he could not help thinking that the time was not far distant. The gentlemen who placed the last two cables in the Atlantic were American gentlemen of great wealth, but they had absolutely no experience of telegraphy. They all knew that on this side of the Atlantic people were obliged to be satisfied with a very moderate rate of interest on their investments; but that was not the case on the other side, where they required a much larger rate before they were satisfied, and he believed those gentlemen, after the experience they would have acquired by the last year's transactions, would not be much gratified with the return which the large outlay they had made on those cables would bring them in. He could not help thinking that before long that consideration would bring them to a state of mind which would make them listen to reasonable terms. At all events, if things did not take that course, this company had always the power of drawing the sword. There was a limit to forbearance. They were unwilling to throw away more money in a battle of rates, but, if necessity arose, it would come to that at last. If they had to go to a battle of rates they were in a very good position to carry it on. They had a perfectly efficient plant, and they had also a very large reserve fund at their back. Going to the accounts, the chairman said it was the duty of the directors, at a time when the receipts were coming in but slowly, to do their utmost to economise in the administration of the affairs of the company. Accordingly, economy had been exercised in almost every item of expenditure in the last half-year, and there was a reduction throughout, beginning with the expenses of the head office in London, £221. The difference between the working expenses abroad for the half-year, and those of the corresponding half-year in 1884, was very large—£4,800; but it was only right to mention that that reduction was due to the cessation of some extraordinary expenses in the last-named half-year; still, there was a substantial reduction in the expenses of the half-year. The repairs to cables, which related to the state of things to which he alluded at the beginning of his remarks, cost, during the last six months, £11,376; consisting of the expenses of the *Minia*, £10,417, and the cost of the cable used, £958. The vessel was not engaged in repairing this company's cables the whole of the half-year, but was chartered to other companies for the repair of their cables, obtaining thus £10,270 sterling, so that in point of fact this company's repairs were effected at very little more than the cost of the cable expended in the operation. He came now to say a few words on the great subject of debate in that room, namely, the renewal fund. They had all probably seen in the papers an account of a meeting of shareholders in reference to this subject. These gentlemen met some fortnight or three weeks ago and appointed a committee, which committee asked to have an interview with the board. The board was not at all above adopting a good precedent—that afforded by the joint action of the two political parties in passing a recent measure of importance—and at once acceded to the request. They would remember that at the last half-yearly meeting the board determined to reduce the contribution to the renewal fund from £150,000 to £100,000 a year; that was to continue for three years, after which the sum was to be still further reduced. After conference with the committee at the beginning of the week, the board came to the decision that as soon as the renewal fund had reached the sum of £1,000,000 no further addition to it should be made for renewal, and that the only sum that should be added after that period should be the interest on the fund itself. That resolution was accepted by the committee as satisfactory. He must state, however, that the resolution was conditional on no breakdown taking place within the next year, for, of course, if any of the cables broke down, it would have to be replaced, and they would have to reconsider their position. Mr. Smith of York, who had led the opposition, had expressed himself satisfied with the decision of the directors and had authorised him (the Chairman) to say that he would not put the resolution of which he had given notice. In his letter, Mr. Smith asked for something further; he asked that the directors should give an engagement that no larger sum than £100,000 should be expended from the renewal fund without the sanction of the proprietors. Well, that involved an infraction of the articles of association, and it could not be done; Mr. Smith's object could not be carried into effect without an alteration in the articles of association. Would they allow him, in all good faith and kindliness of feeling to ask them what necessity there was for such an engagement. Their object could, of course, be seen, and a very just object it was; it was that the renewal fund should only be expended for the purposes for which it was created. Well, what had been the history of that renewal fund? When he (the Chairman) first became connected with the company, they had the '65 cable, the '66 cable, and the French cable. Immediately after the junction between the Anglo-American and the French companies, they laid another cable, which was laid partly with the material which had been provided by the French Company for duplicating its own cable. Immediately after the junction of the two companies they began to accumulate the renewal fund. Therefore none of the cables laid before that period could have been paid for out of the proceeds of the renewal fund. Presently the '65 cable gave out, and by the terms of their agreement with their allies in the pool transaction, they were bound to replace that cable. Fortunately, they had a considerable quantity of material which was to have been laid by the French Company in laying their cable, because the cable this company put down from Ireland to Newfoundland was not nearly so long as that for which the French Company made provision. Therefore, after the '73 cable had been laid, a large part remained and was used to partially replace the cable that broke down, the remainder being provided from renewal. Therefore, the only expenditure which the renewal fund had made up to that time was in repairs, and in assisting in the laying of the cable of '74. Afterwards the '66 cable gave out, and a new cable was laid exclusively out of the renewal fund. They all admitted that the renewal fund was intended to replace the property already existing, and for nothing else. He could assure them that up to the present they had not spent a shilling for any other purpose, and what right had the shareholders to assume that they would do in the future what they had never yet done? Mr. Smith spoke in very flattering

terms of the whole of the present board, and appeared to think all would be well if they could secure immortality. But it seemed to him (the Chairman), that if they were succeeded by another board not so scrupulous, any shareholder could obtain an injunction to prevent the application of the fund for any other purpose than that for which it was created. This being the case, what reason was there in changing the articles of association, discrediting the directors, and thus bringing discredit on the enterprise itself? The board had considered the subject very carefully, and for the reasons he had given could not assent to Mr. Smith's proposition. He concluded by moving the adoption of the report and the declaration of dividends of ¼ per cent. on the ordinary stock, and of 1 per cent. on the preferred stock, making 1¼ per cent. on the former, and 2½ per cent. on the latter for the year ended December 31st last.

Lord Tweeddale seconded the motion.

Mr. Chester asked for the results of the whole year's working of the *Minia*; the chairman had only given the half-year's working.

Mr. Thomas Smith said he thought the shareholders might congratulate themselves that they had now seen the end of the additions to the renewal fund, and that from the 31st December of the present year they would have the use of the net earnings. He might say that his lordship had made a slight mistake. The arrangement come to at the conference was that at the end of the present year no further addition than £100,000 should be made to the renewal fund, and that it should be made up by the interest. The committee trusted the shareholders would accept the arrangement with satisfaction as ending the drain on their resources and leaving for future contingencies the immense sum of £1,000,000. This was a grand backbone, and they had now only to be watchful with regard to the spending of it. He had for some years been compelled to oppose the adoption of the directors' reports; but the directors having now made what he considered a satisfactory statement as to any further additions to the renewal fund, he had much pleasure in supporting the adoption of the report now before them. He did not undertake, however, to blindly follow the directors in whatever they might propose; as in the past, he should in the future, as a man of business, reserve the right to think and to act upon his own independent judgment.

Mr. Chipperfield asked the cost of the last cable.

Mr. Weaver (managing director): Something over £400,000.

Mr. Chipperfield also desired to know what the Mackay-Bennett cables cost. When the renewal fund was started the cost of laying a cable was much greater than now, and the amount necessary to be annually set aside was consequently now much smaller. Were a cable to be laid across the Atlantic now it would not cost £400,000.

Mr. Weaver: Oh, yes it would; £400,000 was the money we spent on the last cable, but there were shore ends of the old cables which were used.

Mr. Chipperfield contended that if the contemplated additions to the renewal fund were made, a sufficient sum of money to put two, if not three cables across the Atlantic, would have accrued.

A Shareholder said they were very glad the matter was already settled; and now they wanted to know how much the committee were out of pocket by their exertions, for they should not be allowed to lose anything, as they had been acting in the interests of the whole of the shareholders.

Mr. Garner protested against that part of the chairman's speech regarding the war. They had nothing to do with other companies. It was for them to work as cheaply as the others, and cheaper if they could. The result of previous "wars" had been that a combination followed, and another company started. But for their adoption of this course they would have had a monopoly, and the whole affair would have been in their own hands.

Mr. Weaver: You would have had no dividends.

Mr. Chester differed from the chairman's remark respecting the elasticity of the traffic, and spoke hopefully of telegraphic communication in the future. He then strongly argued for an alteration in the articles of association, which, he believed, would allow the board to purchase the two cables of the Commercial Cable Company, using portions of the renewal fund for the purpose.

Mr. Stockdale, Mr. Newton, Mr. Jackson, and Mr. Parker having spoken in the same direction,

The Chairman, replying to the remarks made, said Mr. Stockdale was wrong in saying the renewal fund was invested in the names of two members of the board; the securities were in the name of the company, and could only be altered by a resolution of the board under the seal of the company. Rather a false construction had been put upon his use of the word "backbone" in reference to the renewal fund. He merely meant that when they had a renewal fund that would replace all their plant, they might be at perfect ease as to the result of any contest with competitors. He did not mean that that money could be employed directly in conducting the contest. It would be gross malversation if they did use it in that way. The last cable laid cost in money £430,000, but, in addition to that, they had the shore ends of the old cable to make use of, and he thought he was within the mark in saying that that would have brought the sum to £500,000. The total receipts for the whole year from the *Minia* amounted to £26,228 9s.; she was chartered by other companies during the year to the extent of £16,430, leaving a balance of £9,798 9s., which represented the whole of the cost of the repairs during the year, as far as the ship was concerned. They had had a good deal of discussion, but all had been of such an amicable nature that he did not feel it necessary to trouble them with any further observations, and would therefore put the resolution.

The resolution for the adoption of the report was then put and carried unanimously.

The Chairman and Mr. Wm. Barber were re-elected directors, and the auditors, Messrs. Joshua Deane and Francis Glass, were re-appointed, after which votes of thanks to Mr. Thomas Smith and the Chairman and directors were passed and acknowledged.

Anglo-American Brush Electric Light Corporation, Limited.

THE fifth ordinary general meeting of the shareholders of this corporation was held at the Cannon Street Hotel, on Wednesday, the Rt. Hon. Lord Thurlow, presiding.

Mr. E. Garcke, the secretary, having read the notice convening the meeting,

The Chairman, in moving the adoption of the report and accounts, congratulated the shareholders on the improved aspect of affairs, which enabled the directors to recommend the payment of a dividend, a small one, it was true, but one honestly earned during the past year. The position to which they had been restored had not been attained without considerable anxiety on the part of the board and the members of the staff. Having thanked the shareholders for their unremitting confidence, the chairman proceeded to state that the affairs of the corporation now rested on a very strong foundation. The works in Belvedere Road had been fully employed in the execution of good orders during the whole of the year, and the volume of work executed was in excess of that of the previous year by nearly 25 per cent., the net profits of the two years bearing as nearly as possible the same relation. The profits of 1885 would have been much larger but for the extravagance of their predecessors, and the fact of their being hampered with an establishment and premises which were still far beyond their manufacturing requirements; but in the face of the increasing volume of business they did not see how they could now profitably reduce either the establishment or the works. They were now executing a large quantity of genuine, sound and paying orders, which would carry them on for nearly twelve months. These orders were received from Government, from various colonial departments, and from manufacturing firms in England, and for lighting the impending exhibitions at Liverpool, Edinburgh, and Folkestone. A very satisfactory feature was the regularity with which the orders came in, from one quarter or another, and this had enabled them to constantly and fully employ, and sometimes to employ in overtime, 300 men at the works; to these 300 men he took the opportunity of tendering his thanks for the intelligence and zeal which they had displayed in the service of the company. He desired the shareholders to understand that the item under cash at the bank, £924, must not be regarded as the whole of the capital they had at command. They had about £33,000 good debts owing from various customers; last year this item stood at £20,000, and the difference showed a remarkable improvement. The company's debts were also slightly larger than last year, but not more so than was fairly necessitated by the growing business. The chairman then devoted some time to assuring the shareholders that there was absolutely no cause, as far as the actual value of the shares of the company was concerned, for the fluctuations of those shares in the stock market; and he advised shareholders not to sell their shares below par. Another satisfactory thing was, that the public installations run by the company this year showed a substantial profit, against losses in previous years. The exact figures were not yet made out, but the profit was represented by three good figures. The South Eastern Railway Company had a Bill before Parliament for the extension of its line, and the plans were drawn to include a portion of the premises of this company, and, if carried out, would involve serious sacrifices and entitle them to substantial compensation. Petitions had been filed protesting against the action of the South Eastern Company, but if the plans of the latter were carried out he was glad they had waited until this company was in a dividend paying position, as they would receive a higher indemnity than if they paid no dividends. He trusted the negociations with the City Commissioners of Sewers for the lighting of the City were approaching a satisfactory termination, and if the work was entrusted to them they would have to find a large amount of capital to carry out the work. This would not prove difficult, but they were not rushing blindly into the matter, and had determined not to undertake it except upon a paying basis, and with the provisions that the contract should be for a number of years, that they should have the right to lay mains of sufficient size to supply customers on both sides, and that those mains should remain even if the contract with the City were interrupted. For the last eighteen months they had been doing a large business in Germany, but as the result of a visit of himself and Mr. Wynne to Berlin more extensive operations were to be undertaken there, whilst there was a prospect of large schemes of electric lighting in Dresden, Hamburg, and other places. With regard to the amendment of the Electric Lighting Act, they had received a large amount of assistance from numerous influential scientific gentlemen, and a Bill was to be brought before Parliament shortly by Lord Rayleigh. That Bill affected only the two clauses which left it to the option of the consumer to use what lamps he chose and provided for the compulsory purchase of an undertaking at the expiration of 21 years. If that Bill passed, as he felt assured it would, it would be one of the most useful and effectual relief works which could be supplied, and, seeing the tens of thousands of men

who were now without employment, he trusted this fact would have some weight with the Government. The Chairman then alluded to the loss the board of the company had sustained through the retirement of Mr. Ladd and Mr. Courteney, two of the directors, but remarked that they had supplied their places with two gentlemen of eminent scientific, technical and administrative abilities in the persons of Lord Sudely and Major-General Webber. He concluded by moving the adoption of the report, and the declaration of a dividend of 2 per cent. per annum.

Mr. J. S. Sellon seconded the motion, and spoke hopefully of the future of the electrical industry, remarking that this corporation possessed the most comprehensive patents and those most nearly approaching perfection.

The motion was put to the meeting, and carried without discussion or dissent.

The retiring directors, Lord Thurlow, Mr. Sellon and Colonel Stewart, were re-elected, as also were the auditors, Messrs. Cooper Bros. and Co.

This concluded the business, and votes of thanks brought the meeting to a close.

The Phosphor-Bronze Company, Limited.

THE report of the directors states that the net profits amount to £3,216 17s., after writing off the whole of the investment in Osborne & Company, Limited, amounting to £500, £482 12s. 7d. for depreciation of property, and £391 18s. 11d. for bad and doubtful debts. Out of this sum your directors recommend a dividend of 4 per cent. per annum, free of income tax, which will absorb £2,882 9s. 7d., and leave £334 7s. 5d. to be carried to the reserve fund, in liquidation of the debenture liability. The dividend of 4 per cent. will be paid on 27th February next, should the directors' recommendation be adopted. There has been a slight falling off in the sales of the past year as compared with those of 1884, which, considering the state of trade and the continually increasing competition, is not to be wondered at.

The investment of £2,000 in the Société Lazare Weiller and Company will produce a dividend of 5 per cent. per annum, and profit and loss account has therefore been credited with £100. This society intends placing a considerable sum to reserve, so that this investment will increase in value. The fact of Messrs. Lazare Weiller and Company having done a large trade in wire is also encouraging, as it proves the value of the new silicium-bronze telegraph and telephone wire, for which this company holds the patents for the United Kingdom, India, the British Colonies and Dependencies. The sales of wire, rods, tubes, sheet, and other articles produced by the mills, in Birmingham, have been larger in the past year than in 1884; but, unfortunately, owing to the great depression in trade, many of the company's Birmingham tenants have left without paying overdue rents, so that now, instead of obtaining £400 per annum for steam power, as formerly, only about £200 per annum are being paid. Over £163 for rents due in 1884, which were regarded as an asset in the last balance sheet, have been deducted from this year's accounts, owing to the utter inability of the tenants, through want of work, to pay anything. It must not be overlooked that the mills, by producing wire, rods, tubes, sheet, and other finished goods, enable the company to extend the area of its operations, and it requires but a very small extension in the trade of these articles to make the mills highly remunerative; but in order to meet the requirements of the day constant additions to the plant are necessary. The mills, and the old machinery therein, being kept in a good state of repair and preservation, and the expenses connected therewith being debited to revenue, your directors do not think it necessary to write off this year any sum for depreciation thereon.

In the cost of production of the company's goods at the foundry considerable economy has been effected; but as the advertising account has always been a very heavy and constantly increasing item of expenditure, your directors have determined to make a large reduction whilst trade is so depressed. This reduction will be apparent in the next year's accounts.

The torpedo boat is now completed, but the unfavourable weather has hitherto precluded any trial; meanwhile, negotiations are pending for her sale. The legal proceedings in connection with the building of this boat have ended satisfactorily, and at a comparatively trifling cost to the company. The French Government have, it appears, lately ordered two bronze torpedo boats, which circumstance appears to point to the ultimate adoption of bronze for the hulls of these vessels.

In order to secure a return to the company of some of the Liverpool business, and to execute local orders more promptly, your directors have, at a small cost, established a branch foundry there, which they anticipate will prove a profitable venture when the trade in that great shipping port begins to revive. This foundry practically pays its expenses already, and will be the means of securing local orders for castings, which would otherwise not be sent to the company's London foundry.

The company now make and sell gun metal, brass, and other alloys of a similar character, in the manufacture of which no extra expense is incurred, and as its travellers are enabled to take orders from consumers of metals who will not, or cannot, use the more expensive alloys of phosphor-bronze, it is hoped that the company will soon have a much larger volume of trade.

Since the circular issued on the 17th July, 1885, Vice-Admiral Sir J. Edmund Commerell, V.C., K.C.B., M.P., has joined the board, and Mr. J. W. Bushby has just resigned the chairmanship in his favour, but remains a director.

Telephone Company of Austria, Limited.

The adjourned second ordinary general meeting of this company was held at the offices, Walbrook, on Tuesday, under the presidency of Mr. Henry Grëwing.

The Chairman, in moving the adoption of the report, stated that at the date of the last meeting the accounts were not ready to be submitted. They had had to be rearranged in accordance with the requirements of the law of Austria; but after a good deal of correspondence they had been approved and passed by the London office. The results of the working had been very satisfactory, considering that they had had to deal with the worst period of the company's history. The increase both in the number of subscribers and in the revenue steadily continued, and they had every reason to believe that the next report would prove the correctness of their anticipations of future prosperity. He was glad to be able to state that very little damage had been done to their plant during the present winter months, and their exchange communications had been almost uninterrupted. To meet the requirements of Austrian law they had been obliged to alter the date of their financial year, which in future would run from the 31st of March. Their relation with the authorities in Austria, both Government and municipal, were most satisfactory, and he thought this augured well for the future of the company.

Mr. C. L. W. Fitzgerald seconded the motion, which was adopted.

The India Rubber, Gutta Percha, and Telegraph Works Company, Limited.

THE directors' report for the year ending December 31st, 1885, states that the net profit for the past year amounts to £65,862. Adding £40,070 13s. 3d. brought forward and £52,393 15s. premium on new shares issued, and deducting £20,779 interim dividend paid in July, there remains a disposable balance of £137,547 8s. 3d.

The directors have added to the reserve fund £55,000 (which includes the premium on the issue of new shares), and recommend the distribution of a dividend of £1 per share, free of income tax, amounting to £41,600, making, with the interim dividend, a total payment for the year of 15 per cent., and leaving £40,947 8s. 3d. to be carried forward.

In general sales and in cable work the amount of business done has been up to the average of the last few years.

Cables have been manufactured and laid connecting the Cape Verd Islands with the West Coast of Africa, and have been sold to the Eastern and Brazilian Submarine Telegraph Companies.

Coast cables connecting the Portuguese and French possessions in Western Africa are in course of manufacture, to be laid under a guarantee of traffic from Portugal and an annual subsidy from France. About 600 miles are already laid, and the whole line is to be completed during the present year, and worked by the West African Telegraph Company, Limited.

Besides other cable work, 530 miles were manufactured for the Government Indo-European Telegraph Department, and carried out to the Persian Gulf in, and laid from, the company's vessels. The company's share of the work has been handsomely acknowledged by Sir J. U. Bateman-Champain, K.C.M.G., Director-in-Chief, in his report to the India Office, recently published.

The death of Mr. George Henderson, which occurred towards the close of the year, is keenly felt by his colleagues. For more than 20 years he had, as director and chairman, given unwearied attention to the company's interests, often, in times less prosperous than the present, making himself personally liable on its behalf. His health had been failing for some time before his death; but almost to the last the Board had the benefit of his sober judgment and great experience.

The board have appointed Mr. Gray director in Mr. Henderson's place; and it is intended that he shall become managing director.

With a view to this, and to the further strengthening of the board, special resolutions will be submitted to an extraordinary general meeting of shareholders, to be held immediately after the ordinary general meeting.

The last of these special resolutions refers to the company's French works. The directors bear in mind the possibility that such a sale may be advantageously made sooner or later, and desire to have power to act if the opportunity should occur.

Telegraph Construction and Maintenance Company, Limited.—Subject to audit, the directors propose a dividend of 15 per cent. (£1 16s. per share), in addition to the interim dividend of 5 per cent. already paid, making 20 per cent. for the year 1885.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 5th were £2,214, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Great Northern Telegraph Company, Limited. The receipts for January, 1886, were £19,880; for the corresponding month of 1885, £20,800; and of 1884, £19,360.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ended the 5th inst., were £2,814.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month ending January 31st were £3,200.

NEW PATENTS—1886.

1458. "Electro-telegraphic apparatus." J. J. EBEL. Dated February 1.

1469. "Telegraphic printing apparatus." E. EDWARDS. (Communicated by L. A. E. Parment.) Dated February 1.

1470. "Recovering nickel from scraps of metal plated or coated therewith, chiefly designed for the manufacture of anodes for use in electroplating." H. H. LAKE. (Communicated by La Société de Laminage du Nickel.) Dated February 1.

1493. "Dynamo-electric machines." H. J. ALLISON. (Communicated by W. L. Voelker.) Dated February 2. (*Complete.*)

1496. "Electric bells." T. P. C. CRAMPTON. Dated February 2.

1538. "Materials or compositions for use for underground receptacles for electric wires or cables either alone or in conjunction with iron or steel." J. W. BUTLER. Dated February 2.

1539. "Electric cut-out or circuit breaker." F. F. YEATMAN. Dated February 2.

1543. Electric candles." G. IGNATIEV. Dated February 2.

1570. "Codes for telegraphing words or sentences." T. WORKMAN. Dated February 3.

1586. "Flexible compression commutators and switches for electrical purposes." F. R. DE WOLSKI. Dated February 3.

1591. "Telephonic switching apparatus." A. R. BENNETT. Dated February 3.

1610. "Secondary or storage batteries." G. E. DORMAN. Dated February 4.

1636. "Telephones." R. H. RIDOUT. Dated February 4.

1637. "Driving electric light machinery attached to axles of moving vehicles on railways and tramways." J. RADCLIFFE. Dated February 4.

1680. "Arrangements for permitting the use of telegraphic and telephonic apparatus upon the same line." H. H. LAKE. (Communicated by La Société des Téléphones à Grande Distance.) Dated February 4.

1681. "Relay apparatus for telegraphic or other purposes." H. H. LAKE. (Communicated by La Société des Téléphones à Grande Distance.) Dated February 4.

1684. "Secondary electric batteries." B. WEISE. Dated February 4.

1726. "Incandescent electric lamps." L. S. POWELL, R. P. SELLON. Dated February 5.

1747. "Electric sponge." G. EPSTEIN. Dated February 5.

1754. "System of automatic telegraphic apparatus." A. M. CLARK. (Communicated by Mde. Veuve Meyer.) Dated February 5.

1830. "Flying machine which flies off and either leaded by a man or by electricity." (*Sic.*) J. WALDE. Dated February 8.

1860. "Voltaic belts." A. T. SHERWOOD. Dated February 9. (*Complete.*)

1877. "Electric lamps." N. TESLA. Dated February 9.

1887. "Electro-static gas lighter." C. A. TESKE. Dated February 9.

1892. "Extracting metals from substances containing the same by electrolysis." L. GRABAU. Dated February 9.

1899. "Art of telegraphy." G. A. CARDWELL, W. P. ARNOLD. Dated February 9. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

1621. "Improvements in electric arc lamps." W. J. MACKENZIE. Dated February 5. 8d. Relates to a development of the invention described in the specification of letters patent granted to the inventor and dated 7th January, 1882, No. 95. In the invention referred to, the inventor employs a small electro-motor as the power for feeding together the carbons, but he arranges the motor to act in an improved manner, and he uses separate devices for striking the arc, for regulating the feed, and cutting the lamp out of circuit.

1855. "Improvements in apparatus for opening electric circuits to prevent damage, and also for stopping the motor driving a dynamo when its circuit is thus or otherwise opened." T. NORDENFELT. (Communicated from abroad by O. F. Jönsson, of Stockholm). Dated February 10. 8d. The current, in passing through this apparatus, divides and passes simultaneously through two electro-magnets, and, joining again, passes through three insulated rails. One of these rails is fixed, and the circuit between it and another movable rail is completed by each rail having on its end a piece descending into a vessel containing mercury. This vessel is mounted on the top of a vertical sliding bar. A spring tends to draw the bar down, but it rests on a piece connected with the armature of one of the magnets. This armature is held back by a spring sufficiently strong to overpower the attraction until the current has increased to such a degree that danger is imminent both to the dynamo machine and the circuits. The armature of the other electro-magnet consists of a double armed lever provided with metal screws in front of the poles of the electro-magnet, in order to diminish the effect of the residual magnetism. A hook is provided in order to retain the lever in its position when no current is passing through the apparatus. On the opposite end of the lever a weight is suspended, and from the weight a string passes over pulleys to a wheel, which is keyed on to the spindle of the stop valve of the motor in such a manner that the weight, when free in falling, closes the valve.

1857. "Apparatus for regulating the speed of a motor driving dynamo machines." T. NORDENFELT. (Communicated from abroad by O. F. Jonsson, of Stockholm.) Dated February 10. 8d. The apparatus consists of two parts, the first part is placed near the motor of the dynamo machine, it indicates by means of signals any change in the current, and further, by means of the second part, which is termed the regulator, increases or diminishes accordingly the amount of steam supplied to the motor.

1870. "Improvements relating to the use of electricity for the automatic stoppage of railway trains, and apparatus therefor." W. R. LAKE. (Communicated from abroad by R. Snyers, of Brussels.) Dated February 10. 8d. Comprises a vertical shaft carrying at its upper part a horizontal plate. The said shaft is supported in a cast-iron frame having suitable bearings. A spring surrounds the shaft and has for its object to return the latter to its normal position when it has been moved from the same by a rotary motion. A ratchet-wheel keyed upon the vertical shaft has engaging with it a pawl having the form of a small bent lever, one arm of which carries the armature of an electro-magnet. The said ratchet-wheel and pawl serve to maintain the shaft in any desired position which is only altered under the action of the spring when the pawl attracted by the electro-magnet disengages from the ratchet-wheel. The said shaft carries a small cam designed to cause the oscillation of a vessel containing mercury and forming part of an electric circuit. The horizontal position of the bottle corresponds with the passage of the current. The bottle returns to its normal position by gravity, when it is no longer subjected to the action of the cam. The manner in which a train acts upon the apparatus and the apparatus reacts upon the train is as follows:—Each locomotive carries two brushes of very flexible and very elastic steel strips. The first brush placed in front of the engine has a thickness of from 5 to 10 centimetres and a width of from 25 to 30 centimetres. It can oscillate upon an axis; its oscillation being produced by the contact with an obstacle and causes the stoppage of the locomotive. The second brush is placed behind the first brush. It is several metres in length and from 25 to 30 centimetres in width. The said brushes are placed, one on the right-hand side, and the other on the left-hand side of the locomotive in such a manner that the first brush touches the plate only when it occupies a position at right angles to the rails, whilst the second brush encounters it when parallel to the rails, and has especially for its object to place it at right angles to the rails. For this purpose the strips of these brushes extend much lower down than the said plate, and in bending so as to pass above, they adhere and exert sufficient pressure to cause the first brush to oscillate, and to impart to the plate a rotary motion by the action of the second brush. Accordingly, when a train encounters the said apparatus, the plate being parallel to the rails, the first brush passes without hindrance. But the second brush coming immediately after places the plate at right angles to the rails in a position adapted to cause the stoppage of a train which may follow. At the same time that the rotation of the plate takes place, the small cam on the shaft causes the mercury vessel to oscillate and thus closes the circuit which is connected with the electro-magnet of the preceding apparatus. The pawl of this apparatus is then disengaged from its ratchet-wheel, and the plate is carried back to its normal position by the tension of the spring. It will thus be observed that the passage over one section of the line is allowed only when it is free, and when the train which occupied it has reached the following section.

2325. "Improvements in the construction of armatures for dynamo-electric machines." F. WYNNE. Dated February 20. 11d. Relates to that class of armatures for dynamo-electric machines (generators and motors) known as disc or ring type, of which the well known "Brush" and "Schuckert" armatures are examples, and consists of a peculiar way of constructing the said armatures of a ribbon or band of iron.

2834. "Magnetic appliances designed to be worn chiefly for preventing sea sickness." W. L. WISE. (Communicated from abroad by G. Edard, of Paris.) Dated March 3. 8d. The appliances comprise a belt and a sole.

2924. "Automatic electric coupler." J. S. RAWORTH. Dated March 5. 8d. Consists of a magnet or electro-magnet, balanced on pivots and influenced by three solenoids; two of high resistance are shunts between the main leads and between the machine terminals respectively, and are arranged to have opposing influences upon the magnet, so that when the strengths of currents in the two solenoids are equal, the magnet will not move, but if the current due to the machine preponderates, the magnet will turn in one direction on its pivots and make the connection between the machine and the leads. As soon as this connection is made, the currents in the two shunt solenoids become equalised, and the magnet would lose its bias if it were not for the third solenoid,

which is of low resistance, and carries either the whole or an adequate portion of the main current. The magnet is weighted on one side so that it will break connection with the main leads whenever the current ceases to flow through the solenoid of low resistance. If it should fail to act, and current should commence to come back through the machine, this reverse current will instantly move the magnet and break the connection.

2966. "An improved foot-step for telegraph posts, signal posts, and the like." A. E. GILBERT. Dated March 6. 6d. The improved foot-step is formed by stamping or cutting out of sheet iron or steel a bracket-shaped piece of approximately triangular form, with projecting parts on the vertical edge which are bent over on opposite sides to form holding lugs, through which spikes or bolts are passed to secure the footstep to the post, and with a sharp projecting claw at bottom, or top and bottom, to enter the post, and a projection at the end of the horizontal edge forming the tread or foot plate, to prevent slipping. For lightness the central part of the triangular bracket piece may be stamped or cut out.

3004. "Improvements in the construction of cables for conveying electric telegraph and telephone messages, and electricity for motive power and lighting purposes." J. C. SELLARS. Dated March 7. 8d. A cable according to the invention is constructed in the form of a flat band and consists of a number of wires placed side by side and running parallel to one another, the wires being covered by a material made damp-resisting and non-conducting.

3049. "Improvements in the construction and working of galvanic batteries." J. J. COLEMAN. Dated March 9. 8d. One form of the battery is constructed of pairs of elements of iron and copper immersed in cells containing a neutral saline solution of, say, common salt mixed with hyprochlorite of calcium (chloride of lime), or an alkaline solution of a hyprochlorite, by which means a powerful battery is easily formed without the use of porous cells. According to another modification the battery is constructed with pairs of iron and copper, the iron being immersed in a solution of a neutral salt, such as common salt, or of a proto-salt of iron and the copper in a solution of a salt of copper, such as a sulphate.

12897. "Improvements in switches for making and breaking electrical contacts." F. WYNNE. Dated October 27. 8d. Relates to that class of electrical switches, or contact apparatus, in which a spring toggle-joint is employed to retain a contact piece in either of its two extreme positions, and to provide that it is in unstable equilibrium or out of equilibrium in any intermediate position. The principal feature of the invention consists in obtaining this toggle-action by the alternate greater or less compression of a continuous helical spring placed across the line of motion of the contact piece, or pull or push piece, and fixed or secured at both ends.

CORRESPONDENCE.

Electric Alarms and Indicators.

In your issue of the 5th inst., under the heading of "New Patents," I see (No. 993) an electric alarm for hooks and pegs for hanging or suspending goods. Allow me respectfully to inform you that as far back as October, 1883, I made an arrangement for a boot-maker to hang his goods on outside his door, whereby should anything have been taken off the hooks or pegs the electric alarm would have given him notice of same. The working was so simple that I never had any intention of taking a patent out for my invention.

The way in which I made my arrangement was as follows: the hooks or pegs had a spring under them, which, when the weight was taken off, lifted the hook or peg, and so completed the circuit and gave the alarm. Should Mr. S. P. Weston have seen or heard of my arrangement, and it is worth copying, no doubt he will also think it worth recognising, if only by letter.

At the same time, allow me to state (at the beginning of last year), I made an improvement on the ordinary drop indicator, which caused the bell to continually ring until attention was drawn to same. This, Mr. Thurkle I find has fitted to indicators with his name on. I can only say, if the idea is worth using, it would not be out of place for him, or anyone, to thank a workman, like myself, who has it not in his power to patent his invention.

H. Albert.

Electric Light Department,
Army and Navy Hotel,
Westminster, 6*th February*, 1886.

Telegraph Cables.

Can any one kindly inform me where I can procure a map of the world showing all the existing telegraph cables, and to what companies they belong?

E. O. W.

[We think our correspondent should apply for the map to Le Bureau International des Administrations Telegraphiques, of Berne, but it would probably be necessary to seek information from the cable companies also, respecting the lines they control.—EDS. ELEC. REV.]

Transmission of Power by Electricity in Mines.

Our attention has been called to some references in your columns to our experience here, underground, with electrical transmission of power, which now extends over several years. We will, before long, with your permission, put before your readers the results of this experience so far as practical working is concerned. We may say, so far it has been satisfactory and that we have been and are still extending its application.

Frank Brain, M.E., *Manager.*

Trafalgar Collieries,
Drybrook, Gloucestershire.

Electro-Magnetic Induction.

Professor Hughes has recently shown that the action of the current of a conductor upon a neighbouring conductor is the same as the action of the current flowing through a small portion of a conductor upon the remaining portions of that conductor.

The results of Prof. Hughes's experiments together with Lenz's well-known laws, suggest to me the following simple rules:

The electro-magnetic inertia of a conductor varies as $\frac{1}{\text{diameter}} = \frac{1}{D}$, so that the inertia of a unit length of a conductor carrying a constant current would vary as $\frac{1}{D}$. But if the current varied as the sectional area of the conductor, that is, if the current's density was kept constant, then the inertia of the conductor would vary as $\frac{D^2}{D} = D$.

The inertia of the conductor also varies as its length. Therefore the inertia of the conductor would be proportional to $L \times D \times$ current's density.

Since the volume of the conductor $\propto L\,D^2$, the inertia of the conductor would be proportional to $\frac{V}{D} \times$ current's density.

The coil of an electro-magnet should be treated as one conductor having a sectional area proportional to the sectional area of the coil; so that the inertia of electro-magnets is proportional to the square of their dimensions.

There would appear, however, to be an essential difference between the longitudinal and lateral inertia of a conductor; the former seems to control the induced E.M.F., the latter the *duration* of the extra current.

W. Moon.

February 8th, 1886.

Mechanical Telephone Patents.

It would be interesting to know what it is that constitutes a valid patent in the mechanical telephones now being offered to the public. The principle is as old as a Morse instrument. I believe wheel line-guides are claimed for one thing; if so, I can easily prove having used them many years ago.

Telegraph Engineer.